ORDNANCE

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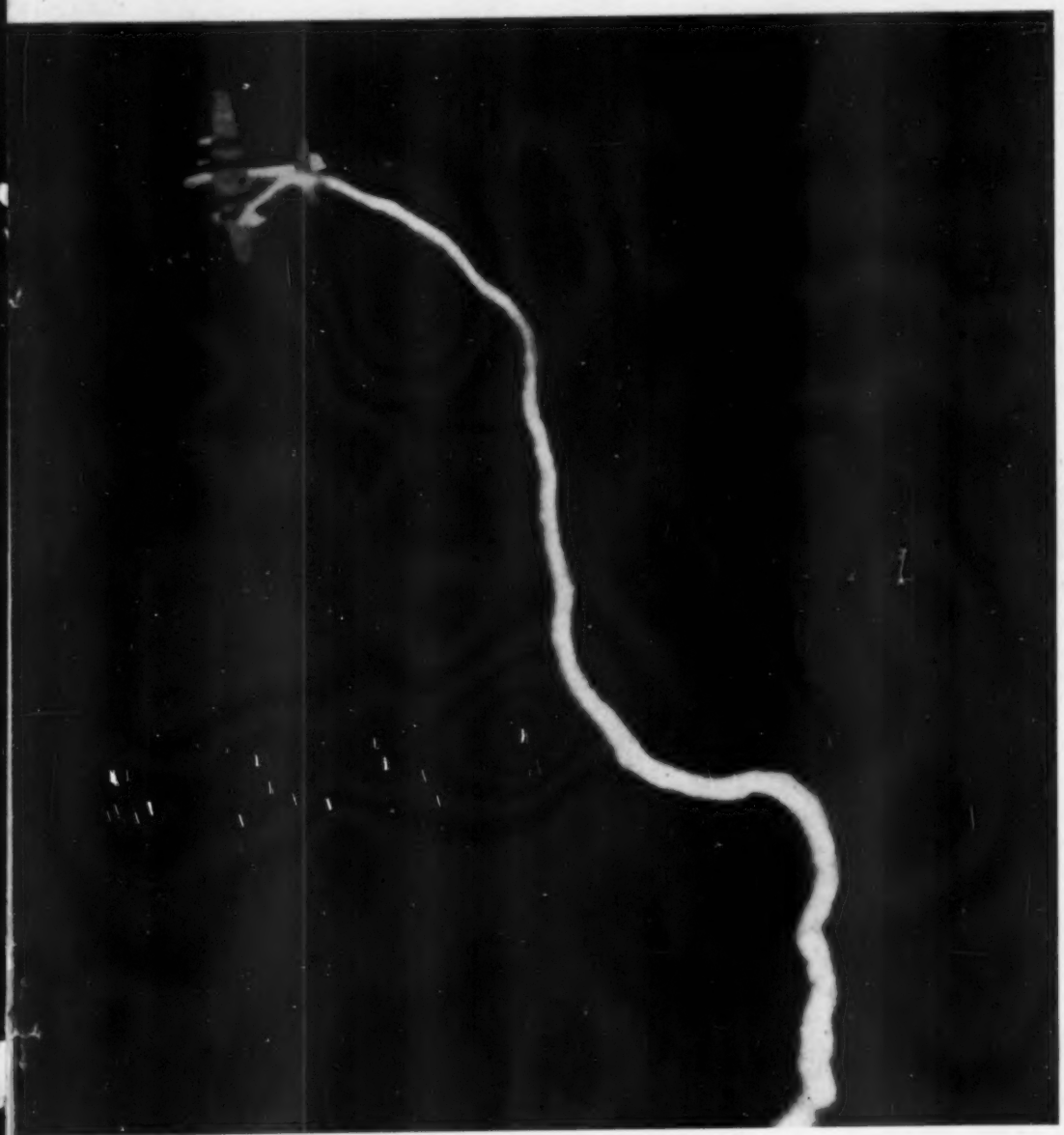
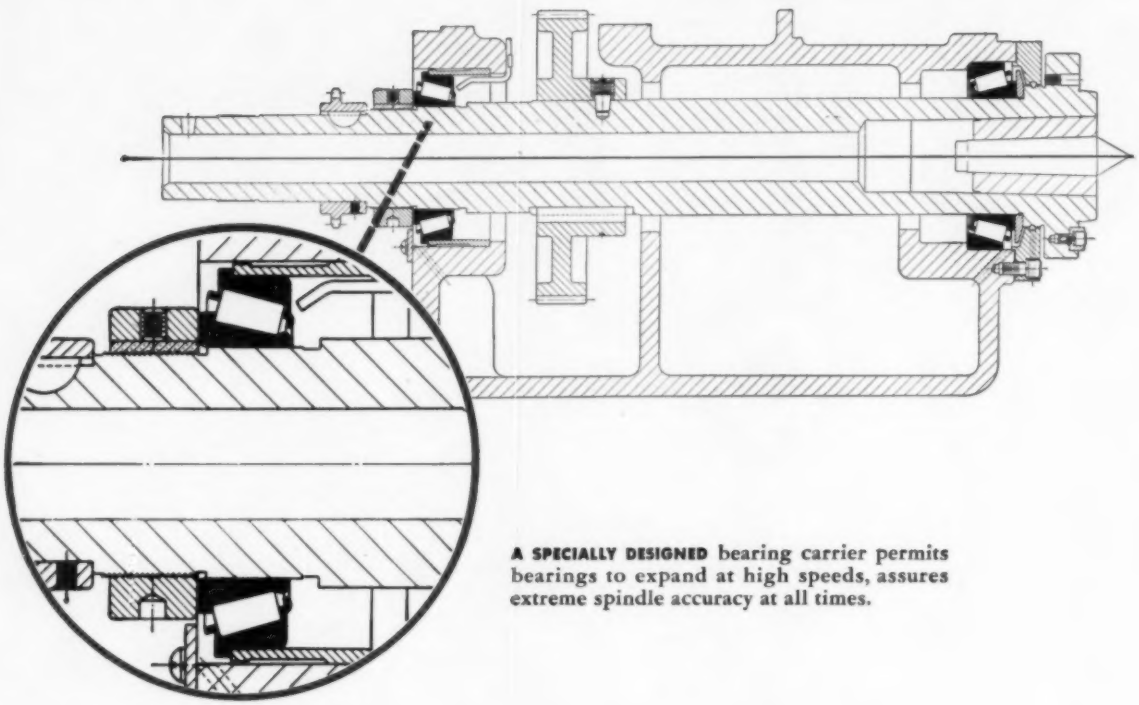


Trail of the Falcon

MAY-JUNE 1955

How to maintain extreme spindle precision from low to very high speeds:

TIMKEN® bearings with semi-flexible mounting



A SPECIALLY DESIGNED bearing carrier permits bearings to expand at high speeds, assures extreme spindle accuracy at all times.

THE Timken Company has an ingenious solution to the problem of maintaining a high degree of spindle precision in machine tools. At high speeds, bearings expand. Normally this would cause the bearings in a precision mounting to tighten up and become excessively preloaded. But engineers at the Timken Company have developed a semi-flexible mounting. The rear spindle bearing is mounted in a special carrier. The carrier is designed to permit the rear bearing to expand radially while the entire spindle assembly expands longitudinally. As a result the desired bearing setting is maintained under all operating speeds. Extreme spindle accuracy is maintained at all times.

Timken® tapered roller bearings with these mountings have been applied to the spindles of many types of machine tools with great success. Of course not all machine tool spindles are required to operate at high speeds and over a variable range of speeds. The conventional Timken spindle mounting is entirely adequate for most machines.

Whatever your requirements, there are Timken tapered roller bearings to meet them. If not we'll find a new way, as we did when machine tool builders originally asked for precision bearings. And as we did when they asked for greater accuracy, which led to the famed Timken "O" and "OO" bearings. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

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ORDNANCE

LAND · SEA · AIR

The Magazine of Scientific and Industrial Preparedness

VOL. XXXIX | MAY-JUNE 1955 | NO. 210

The Cover.—*The twisting path of the Air Force's Falcon supersonic guided air-to-air rocket as it pursues a target drone indicates its unerring ability to follow an elusive quarry.*

Editor: Leo A. Codd. *Managing Editor:* R. E. Lewis. *Editorial Staff:* M. L. Van Horn, R. K. Smith.

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FEATURES

Trail of the Falcon . . . . . **Front Cover**
Official Air Force photograph of the new air-to-air guided rocket

Hon. Charles S. Thomas . . . . . **Frontispiece**
Official photograph of the Secretary of the Navy

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A discussion of the characteristics of lightweight weapons now being tested

Electronics for Ordnance . . . . . **Dr. C. M. Hudson** 1007
Applications of electrons to the field of weapons are increasing rapidly

Caterpillar announces

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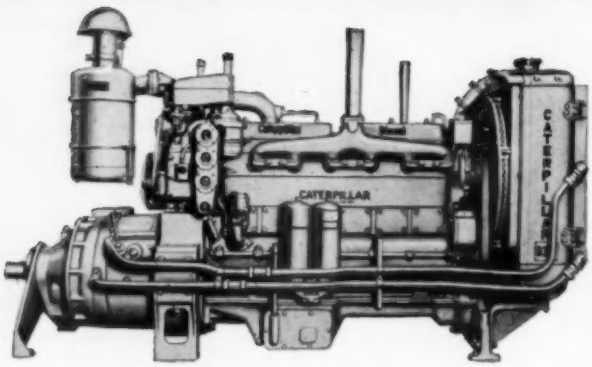

Now, to provide you with a greater selection of power packages, Caterpillar offers a new line of torque converter units. As many as twelve different torque converter arrangements are available for *each* of six Cat Engines, up to 480 HP. Whatever your power needs in locomotives, rail cars, excavators, emergency and locomotive cranes, you'll find the right unit in Caterpillar's complete line.

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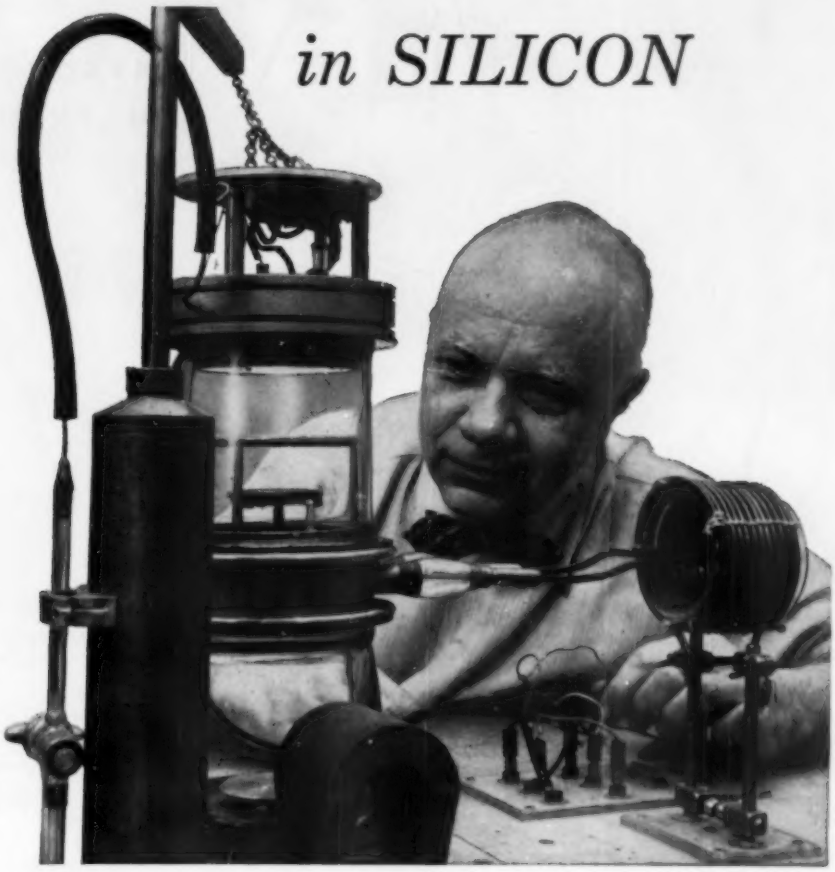

One example of junction technology at Bell Laboratories. Here a junction is produced on the surface of silicon by bombardment with alpha particles. Bombardment enhances silicon's performance at very high frequencies.

One day in the 'thirties a revolutionary adventure began for Bell scientists. They were testing an experimental silicon crystal they had grown to make microwave detectors.

Intriguingly, they found that one end of the crystal conducted by means of positive charges, the other end with negative. Positive and negative regions met in a mysterious barrier, or junction, that rectified, and was sensitive to light. It was something entirely new . . . with challenging possibilities.

The scientists went on to develop a theory of junction phenomena. They showed that two junctions placed back-to-back make an amplifier. They devised ways to make reproducible junctions. Thus, junction technology came into being, and the 20th Century had a new horizon in electronics.

This technology has already produced at Bell Telephone Laboratories the versatile junction transistor (useful in amplifiers and switches); the silicon alloy diode (surpassingly efficient in electronic switching for computers); and the Bell Solar Battery which turns sunshine directly into useful amounts of electric current.

This is one of many adventures in science which make up the day-to-day work at Bell Laboratories . . . aimed at keeping America's telephone service the world's best.

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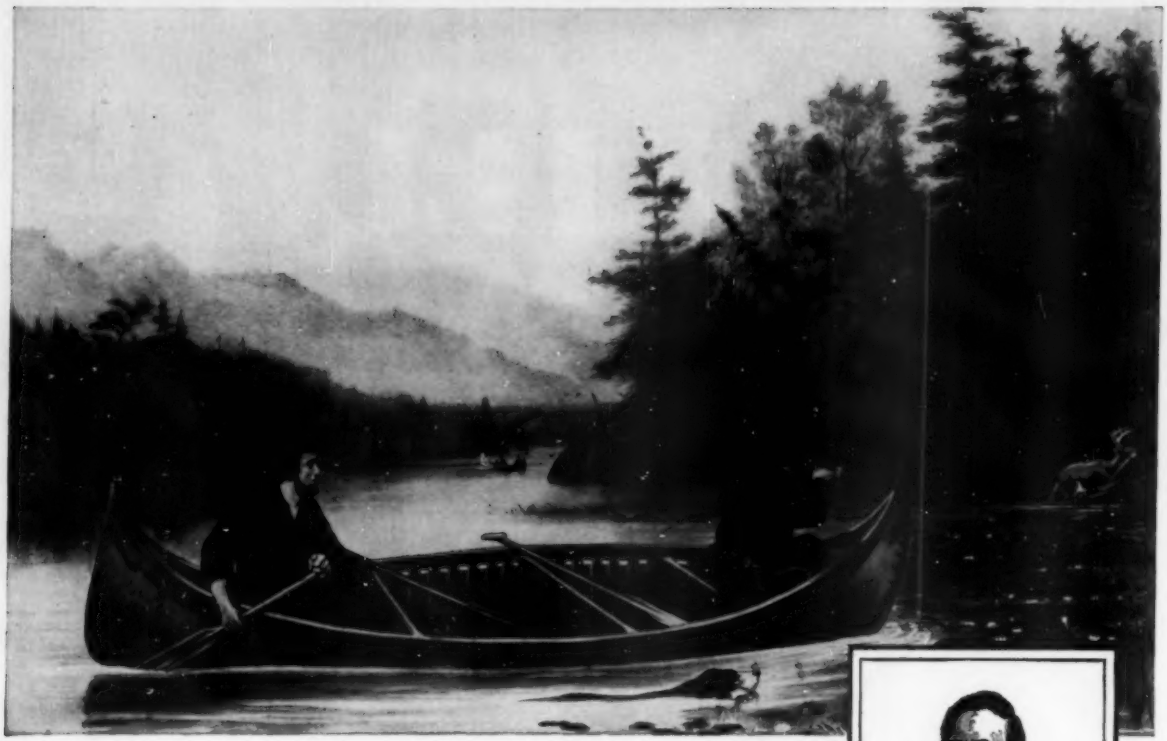

Hunting—and the Man Who Had a Name to Live up to

Young brother of Gen. George Rogers Clark, William Clark carved a man-sized niche for himself among America's greats. While only 22, this tough frontiersman helped put down Indian uprisings in the Ohio Territory. Then came 1806 and his chief claim to fame: blazing a trail with Lewis all the way to the Pacific Ocean—the first expedition to cross the U.S.

Naturally, hunting was a necessity in Clark's way of life: "We saw 37 deer on the banks and in the rivers today, 5 of which we killed"; "I killed a very large and the whitest woolf I have ever seen." Still, accounts by contemporaries show that the hunt was also his favorite pastime: "Captain Clark hunted with the Indians and shot 10 buffalo" and "Captain Clark this evening killed one Elk & a deer." Hunting was in the man's blood—and in his heart.

Since pre-Revolutionary days, Americans from all walks of life have enjoyed the thrills only hunting can provide. It's a sport that challenges wits, reflexes, stamina and skill. Equally important, hunting helps build self-reliance and endurance . . . a valuable contribution to the nation's well-being.

Today, the great American tradition of hunting can be perpetuated only by thoughtful preservation of wildlife. Throughout the country hunting associations are cooperating with public agencies to promote proper conservation. Do your part in preserving this heritage—join or support one of these groups now. E. I. du Pont de Nemours & Co. (Inc.), Explosives Dept., Wilmington 98, Delaware.

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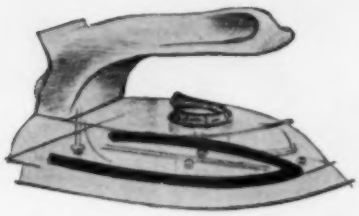
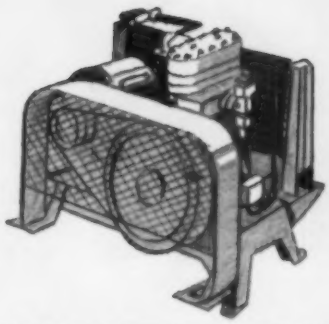


SHEATH FOR HEATING ELEMENT IN HAND IRON



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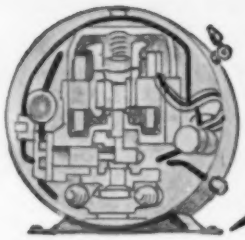

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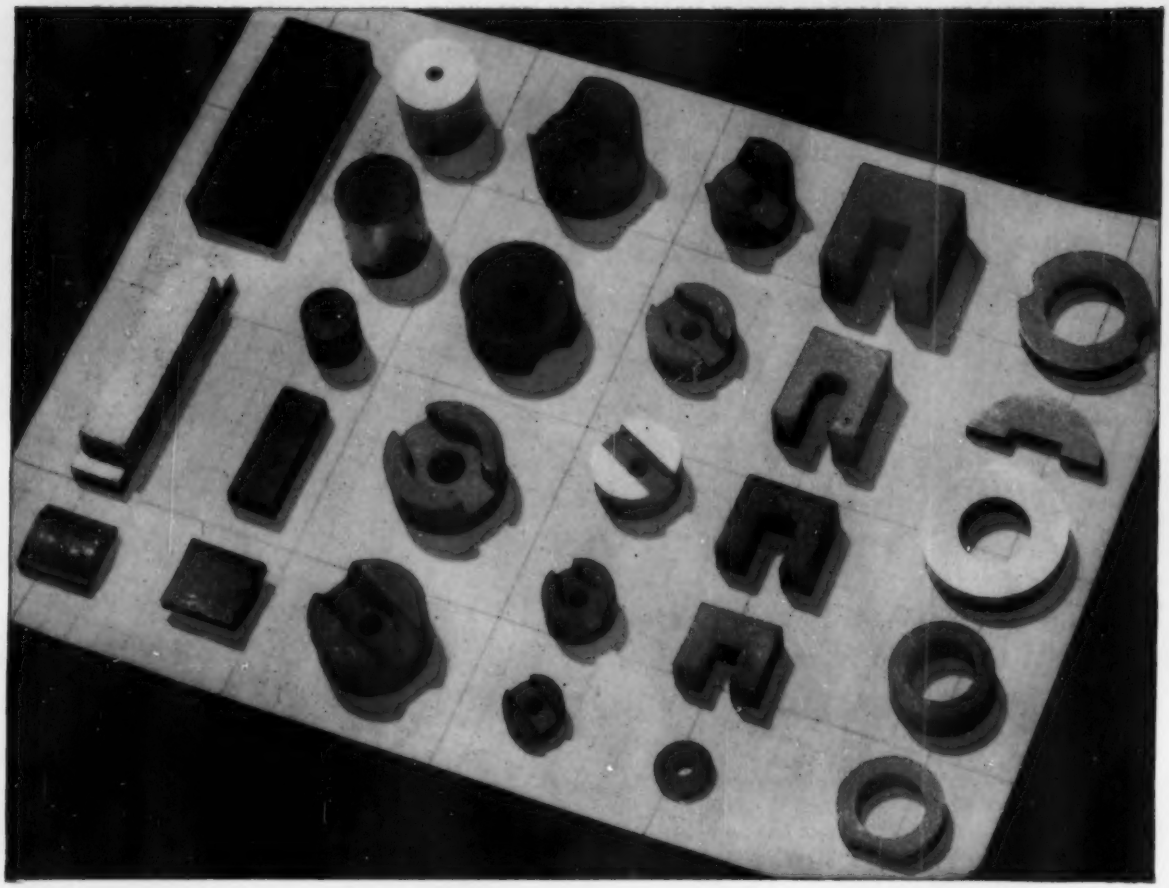

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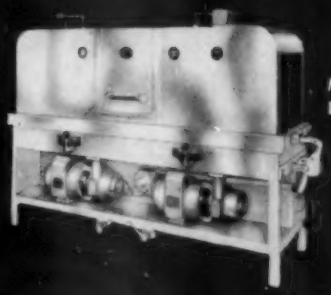

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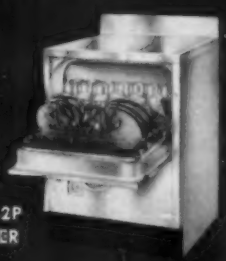

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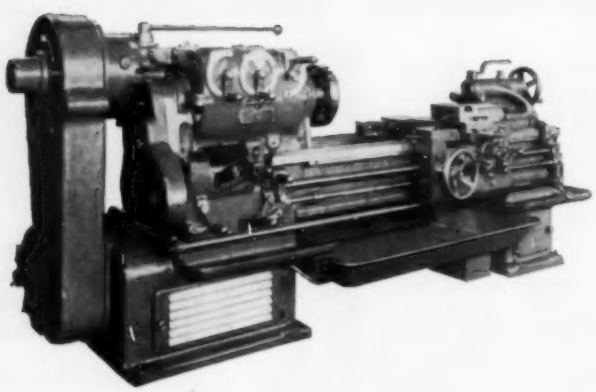
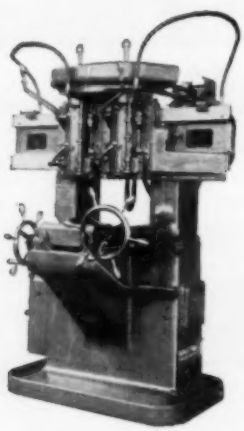
HOE's ability to fulfill contracts for precision machines rapidly and economically stems from the wide experience and extensive plant equipment necessary for the manufacture of large printing presses.



Lathe



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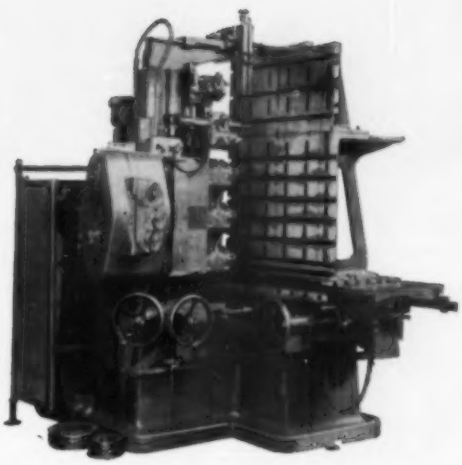
To learn how HOE can help you meet contract commitments or assist you in the production of precision machinery or machine parts, let us know when it would be convenient for a HOE representative to call on you.



Keller machine

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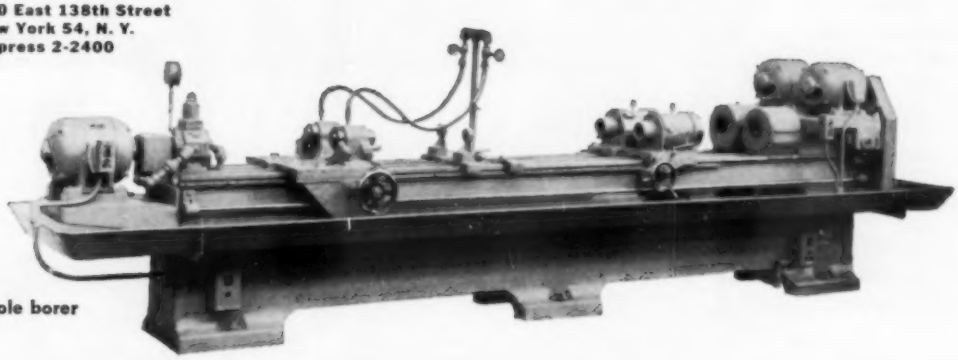

Deep hole borer

Now I know how King John V felt!

I've had it in mind for a long while . . . to give something to our church as a memorial for my son. He didn't come back from Korea.

Among all the ideas that came up, several people suggested a carillon installation. I usually answered—who's got that much money? Oh, I knew about the Bok Tower, and that John V gave the beautiful bells at Mafra to the people of Portugal. But I'm just a fairly well-to-do businessman, not a king or a millionaire.

Then our pastor, seeing that I was really serious, introduced me to a sales representative who'd been calling on him. That's the way I learned about *electronic* carillons.

Using tiny bars of metal in place of half-ton bells, a keyboard any pianist or organist can play, and amplifying equipment of the sort used in public buildings, Stromberg-Carlson designed for us an installation which, except for weight and cost, is the equivalent of 38 huge cast bells! They even added an automatic attachment that starts and stops special music at any pre-set time of day.

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Radios and High Fidelity Radio-Phonographs

Sound and Public Address Systems

Office Intercom Equipment

Precision Turning and Boring

Precision Boring

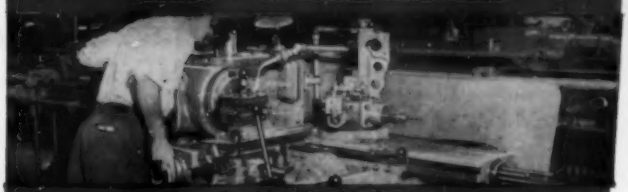
Precision Welding

Instrument Plating

Precision Gear Cutting

Hobbing 56" Ring Gear

Precision Boring, Turning and Threading



Precision Turret Lathe

...from drawing board

—TO FINISHED PRODUCT, DAYSTROM DOES THE COMPLETE JOB.

A modern plant of 350,000 square feet ... the finest machinery and equipment for the manufacture, assembly and test of precision electronic, electro-mechanical, mechanical and nuclear instruments ... add to these a highly skilled staff of research, development, engineering and manufacturing specialists and an experienced management ... means Daystrom can do the complete job, from drawing board to finished product ... ALL UNDER ONE ROOF!

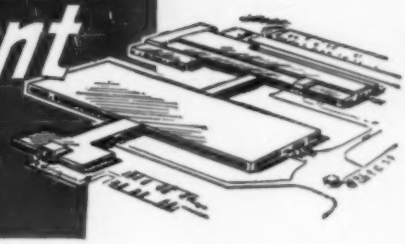
Daystrom Instrument

Archbald, Penna.

Division of Daystrom, Inc.

Daystrom Affiliates:
American Gyro; Heath Company;
Daystrom Electric Corp.;
American Type Founders, Inc.;
Daystrom Furniture Div.

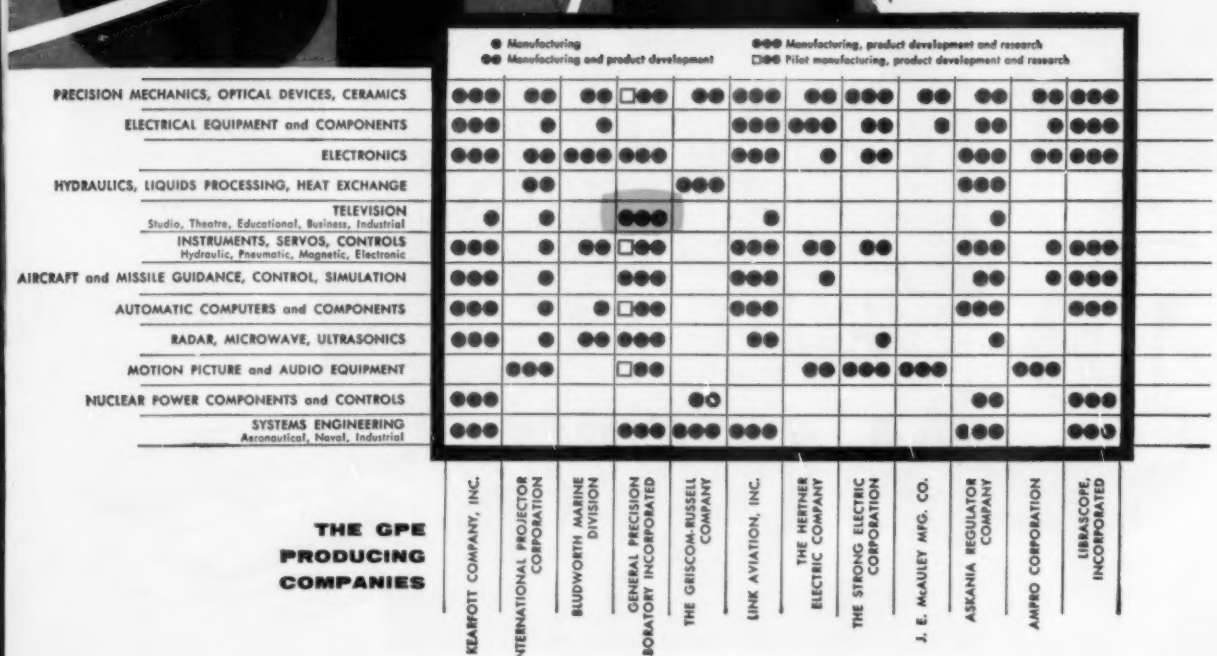
Write For Our Brochure



GPE

BUILDING BLOCKS

serving industry through coordinated precision technology



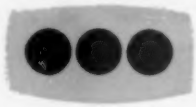
THE GPE PRODUCING COMPANIES

One of a series telling how the producing companies of General Precision Equipment Corporation are contributing to America's progress.

advanced techniques & resources

The producing companies of General Precision Equipment Corporation are engaged in the development, production and sale of advanced technological products. Each of these companies specializes in particular areas of advanced competence and possesses highly developed techniques and resources in its particular field or fields. These are the building blocks of GPE Coordinated Precision Technology, through which GPE serves more than a dozen important industries.

The chart at the left shows the areas in which each GPE Producing Company works. But it cannot show the high degree of specialization and the important position each GPE Company occupies in its field or fields.



Take **TELEVISION,** for instance, and the work of General Precision Laboratory Incorporated, the GPE leader in the field. GPL's research, development and manufacturing activities in TV are concerned with quality equipment for theatre, studio, business, industrial, institutional and military TV and do not relate to the home TV field. In all the areas in which GPL operates it has played an important part in the making of television history.

¶ GPL equipment was used for all video recording of the Coronation, both U. S. and Canadian. It is used by 90% of the studios equipped for video recording.

¶ The first appearance of a President on closed-circuit TV—President Eisenhower speaking from the White House to distinguished guests at the dedication of the Ford Research Center in Dearborn—was projected via GPL equipment.

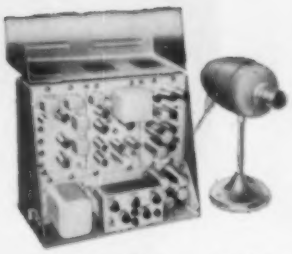
¶ High quality portable projection equipment, newly developed by GPL, enabled guests assembled in several separate ballrooms of the Waldorf-Astoria to see and hear the Queen Mother at two New York dinners last Fall; made possible the historic 53-city TV hook-up which was a feature of GM's fifty-millionth car celebration. This equipment played a key role in the recent nationwide "heart-video-clinic"—the largest meeting of its kind ever held—attended by over 20,000 heart specialists in thirty-five cities. It is rapidly making closed-circuit TV a practical, everyday business and institutional meeting medium.

¶ Many broadcast studios, including CBS's famous TV 61—the largest in the East, are exclusively equipped with GPL cameras and control equipment.

¶ New uses are developing steadily for GPL's "Bullet," the new, portable, easily operated, industrial television camera: in banks to speed service, eliminate congestion and reduce personnel costs; in railroads to better control and speed train make-up and freight car loadings; in industry to monitor and improve manufacturing processes, for surveillance and security, and to view hazardous operations.

GPL is a leader in military TV with its special and exacting requirements for airborne, shipboard and under-water uses and is also at work on color TV. A color film camera chain of high quality, for studio use, is in production and additional color equipment will be announced in 1955.

A broad description of the work of GPL and the other GPE Companies is contained in the GPE brochure, "Serving Industry Through Coordinated Precision Technology." For a copy, or other information, address:



The "Bullet" TV Camera; for industrial, institutional and educational use. Produces useful pictures under conditions of poor light; feeds any TV receiver or monitor; unique packaging permits placement in ordinarily inaccessible areas; unitized construction with plug-in component chassis minimizes maintenance requirements.

Projection TV System; projects bright, clear pictures on screens from 3' x 4' to 9' to 12'. Completely self-contained; easily transported; set up in matter of minutes; does not require skilled operator. Designed especially for closed-circuit meetings in hotels, clubs, auditoriums.

Remote Control TV Camera; for broadcast and industrial use. Pre-set control permits memory of 6 different shots. Mounted on servo-operated pedestal, provides complete remote control of lens selection, iris, pan and tilt. Highly useful for observing dangerous phenomena; permits broadcasting without use of camera man.

General Precision Equipment Corporation

92 GOLD STREET, NEW YORK 38, NEW YORK

HEADS OR TAILS
...WE SERVE

Directly we serve the Armed Forces by supplying them with armored vehicles and artillery shells...aircraft parts and electronic devices...railroad freight and hospital cars ...and other vital equipment.

Indirectly we serve the Armed Forces by bolstering the nation's production strength with hundreds of industrial products ...ranging from heavy-duty valves and storage tanks to bakers' mixing bowls...from featherlight instruments to giant castings.

Heads or tails... ***we serve the nation!***

acf **INDUSTRIES, INCORPORATED**
30 Church Street, New York 8, New York

DANLY

MECHANICAL PRESSES . . .
50 TO 3000 TONS
HYDRAULIC
METALWORKING EQUIPMENT

Danly offers any press you need for blanking, drawing or any other secondary operation . . . single, double or triple action . . . overdrive or underdrive . . . to suit your plant layout. Make your press line a Danly line and save costs at every stage of your stamping operation.

Drawing

COSTS LESS ON A DANLY PRESS

Performance in the country's largest and newest stamping plants proves that Danly Presses cut operating costs. On the record, they are easier to install, run longer without maintenance, increase shift output averages.

Danly's heavier construction gives reserve strength to meet the demands of continuous peak load operation. Ingenious fully enclosed arrangement of integral electrical and pneumatic control devices simplifies installation, makes operation easier and safer.

Features like Danly's exclusive, cool-running clutch and brake and automatic oil lubrication actually add hours of production time to every working day.

Write for complete information today.

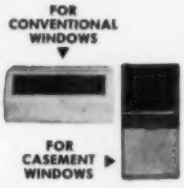
DANLY MACHINE SPECIALTIES, INC.

2100 South Laramie Avenue, Chicago 50, Illinois

When you come to air conditioning...

come to **Airtemp**
DIVISION OF CHRYSLER

. . . for precision-engineered equipment that meets every requirement best

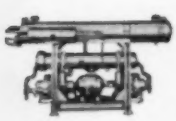


ROOM AIR CONDITIONERS. *Conventional Window Models* in ½-, ¾- and 1-hp capacities. Ideal for home or office use. Reverse-cycle operation of Custom models provides heat for chilly days. *Casement Window Models* in ½- and ¾-hp. Easy inside installation without cutting or removing glass—nothing projects outside.

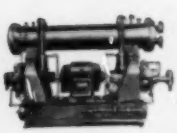
WATERLESS "PACKAGED" AIR CONDITIONERS. In 2-, 3-, 5- and 7½-hp. Use no water, need no plumbing—all-electric operation. "Packaged" model shown is complete with condenser and coil. "Custom" unit with condenser for outdoor or indoor installation.

WATER-COOLED "PACKAGED" AIR CONDITIONERS. 2-, 3-, 5-, 8-, 11- and 15-ton capacities. Cool, dehumidify, filter and circulate air. Free air discharge or duct distribution. Heating coil optional. Compact, space-saving design.

INDIVIDUAL ROOM AIR CONDITIONING UNITS. Used for year 'round heating and cooling by connecting to circulating cold and hot water system. Ideal for hotels, motels, offices. Three types—floor, wall and ceiling. Built-in controls. Two centrifugal fans provide circulation.



"PACKAGED" LIQUID COOLERS. Supply chilled water for refrigerated cooling in central system air conditioning of buildings of all types. For use with Freon 12, sizes 3- to 75-hp. For use with Freon 22, sizes 25- to 125-hp. A completely assembled unit—piped, pressure tested, dehydrated and supplied with a refrigerant holding charge.

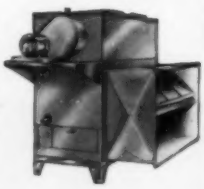


RADIAL COMPRESSOR UNITS. In 10- to 125-hp capacities, these heavy-duty units for use with Freon are especially designed for air conditioning or refrigeration. Radial compressors are direct connected and have force-feed lubrication. Automatic capacity-reduction. Light weight, economical to operate.

CENTRAL PLANT "PACKAGED" AIR CONDITIONERS. Self-contained Central Type "Packaged" Air Conditioners of 25-, 40-, 60- and 100-ton capacities. Utilize the Airtemp Radial Compressor with its exclusive features. Available with evaporative condenser or for use with cooling tower.

EVAPORATIVE CONDENSERS. In sizes from 3- to 100-hp, for either indoor or outdoor application in central type air conditioning systems. Perform function similar to that of water-cooled condenser and cooling tower combination. Sectional construction. Protected inside and out against damaging corrosion.

AIR HANDLING UNITS. These unit air conditioners, in floor and ceiling types, are available in capacities from 1.5-hp to 175-hp for handling air in volumes from 480 to 37,000 cfm. Designed to cool, dehumidify, heat, humidify, filter and circulate air.



COOLING TOWERS. In capacities from 3- to 100-hp. Designed to save up to 95% of the normal water requirement for all types of air conditioning equipment from the simple "packaged" air conditioner to the large central plant system. Adaptable for outdoor use.

Airtemp
DIVISION OF CHRYSLER

DAYTON 1, OHIO

AIR CONDITIONING • HEATING FOR HOMES, BUSINESS AND INDUSTRY

Bendix Products Division

A good reliable source

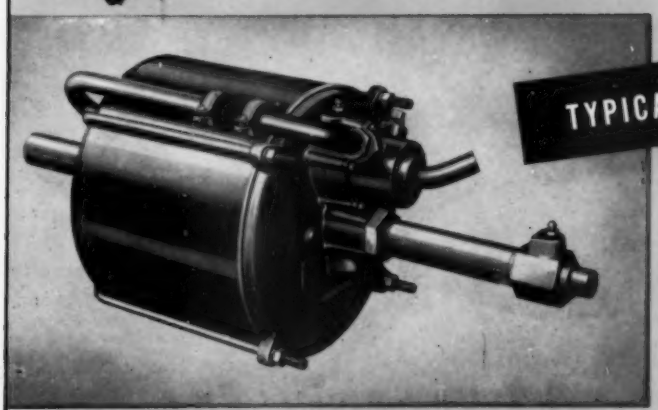
FOR AUTOMOTIVE COMPONENTS

Because of long experience, serving many customers,

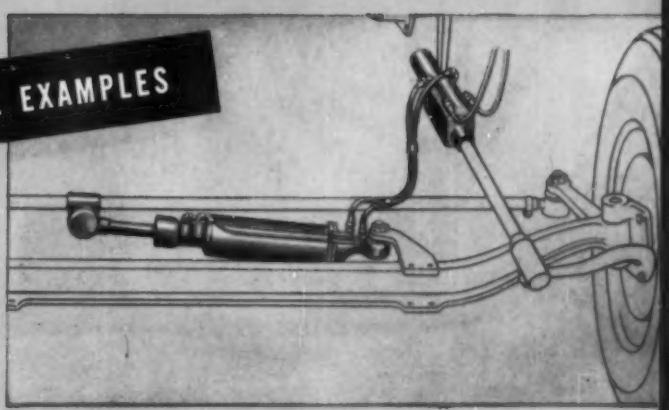
Bendix Products Division can apply much of the combined know-how of the automotive industry

to any specific project in the design and manufacture of automotive components.

TYPICAL EXAMPLES



BENDIX HYDROVAC POWER BRAKE—With over four million in use, the Bendix Hydrovac® is the world's most widely used power brake for commercial vehicles. This overwhelming preference for Hydrovac is a result of sound engineering design, exceptional performance, low original cost and minimum service upkeep. Make the industry's choice your choice.



BENDIX LINKAGE TYPE POWER STEERING—Because Bendix® Power Steering is of the linkage type, manufacturers find it especially adaptable for production line installation without extensive engineering changes. Manufacturers can now meet the ever-increasing demand for power steering more efficiently and more economically with Bendix Linkage Type Power Steering.

®REG. U.S. PAT. OFF.

BRAKES • POWER STEERING • POWER BRAKING • CONSTANT VELOCITY UNIVERSAL JOINTS • HYDRAULIC REMOTE CONTROLS

BENDIX PRODUCTS DIVISION **SOUTH BEND** INDIANA

Bendix AVIATION CORPORATION

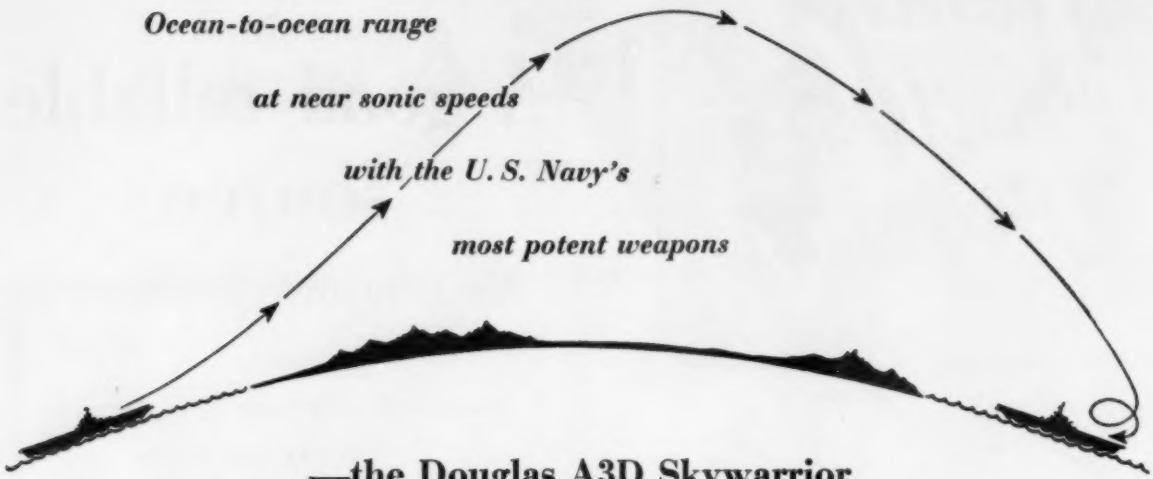
Export Sales: Bendix International Division, 205 East 42nd Street, New York 17, N. Y.

Ocean-to-ocean range

at near sonic speeds

with the U. S. Navy's

most potent weapons



—the Douglas A3D Skywarrior

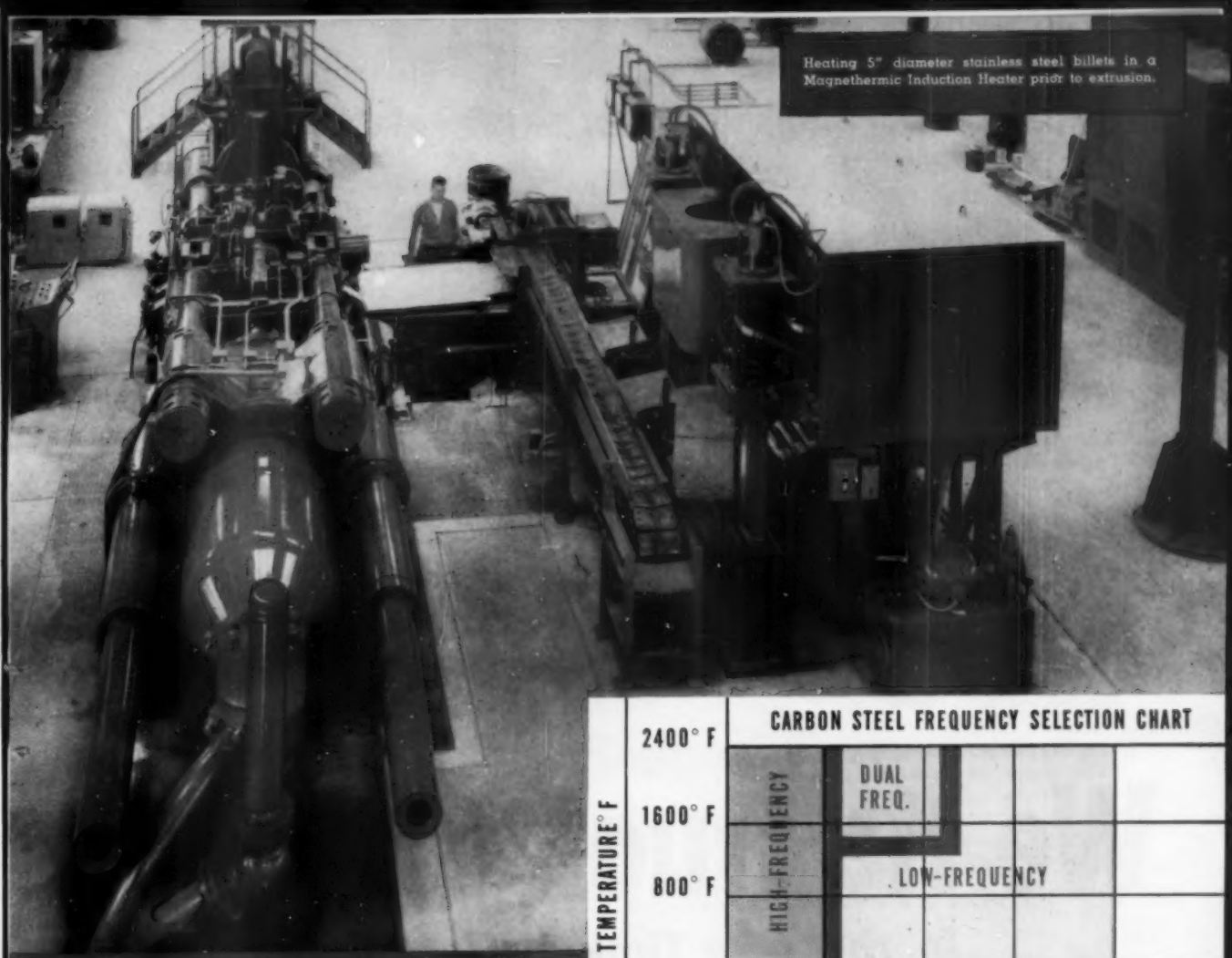
Largest of all carrier-based aircraft, the Douglas A3D Skywarrior adds new punch, speed and "reach" to the striking force of our fleet air arm.

Skywarrior catapults or sprints from carrier decks to fly in the 600-700 mph class. Its great range with huge payload would permit taking off from a carrier in one ocean, completing a mid-continent bombing mission, and continuing to a waiting carrier in an opposite ocean. Further, its simplicity of airframe allows wide flexibility in the missions it can handle. In short, the twin jet A3D Skywarrior carries on the Douglas tradition of more airplane per dollar.

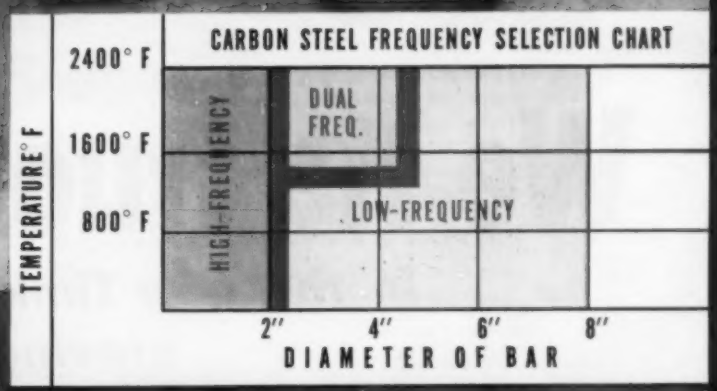
Designing planes that will fly farther and faster with a bigger payload is a basic Douglas concept . . . a concept which has made Douglas the largest aircraft manufacturer in the world.

Be a Naval Flier—write to
Nav Cad, Washington 25, D. C.

Depend on *DOUGLAS* First in Aviation



Heating 5" diameter stainless steel billets in a Magnethermic Induction Heater prior to extrusion.



FORGE WITH INDUCTION HEATING

AND DO A BETTER JOB

With induction heat, a 5" diameter steel billet reaches forging temperature in less than five minutes. This rapid heating cuts operating costs by minimizing scale loss, maintenance costs, manpower and floor space. The equipment can be fitted into an automatic processing line, making billet pre-heating just one minor step in a forging operation. This is why modern production forging and extrusion plants are buying induction heating equipment.

Regardless of size of work or frequency, Magnethermic builds the equipment to meet your need. This company specializes in Induction Heating equipment, low-frequency or high-frequency, through 10,000 cycles. Write to Magnethermic for bulletin or information about your specific questions.

60 THROUGH 10,000 CYCLES

INDUCTION HEATING

MAGNETHERMIC®

corporation

3990 SIMON ROAD · YOUNGSTOWN 7, OHIO

60 THROUGH 10,000 CYCLES

We tie truck axles in

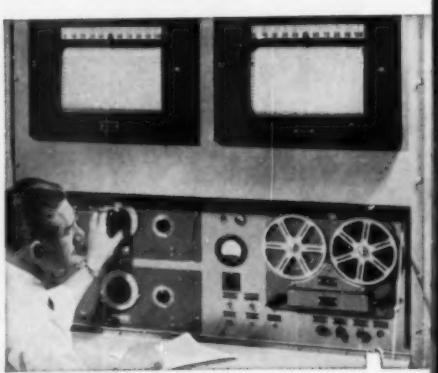
in the new Timken-Detroit indoor proving ground . . . and only

We torture them . . . shock-load, over-speed and jerk them . . . twist, strain and abuse them. We match every on-the-job hauling condition . . . then throw in a few devilish tricks of our own!

The result? You know for sure that *any* Timken-Detroit axle can take more abuse on the job it was built for than any other axle made!

To prove it, we moved a huge proving ground indoors. In one room we can simulate any hauling situation — our engineers can apply 50 years of experience to perfecting axles for modern trucks, buses and trailers, and measure performance with scientific precision.

This research pays off in longer truck life; less maintenance, repairs and downtime; lower operating costs. No wonder Timken-Detroit axles with Hypoid gearing rate "first" with wise truck owners!



This is our "truck driver." He works in our "Torture Chamber." Above him are graphs showing speed and torque performance under any operating condition he chooses . . . soft ground at full load . . . mountains . . . express highways or side roads. With special dials, recorders and electronic devices, he actually *drives* the axle with scientific accuracy from his chair!

How TDA proves axle quality in this "Torture Chamber"

We pick one of our axles at random . . . then duplicate a hauling condition, hour after hour, day after day . . . simulating half a million miles of the toughest driving situations in just a few days. Or "invent" a test like going uphill with a full load from California to New York nonstop. There is no other axle testing like it in the world!

No matter the twist, thrust or shock...Timken-Detroit axles can take it! Regardless of load, road and speed conditions... even the impossible... the new Timken-Detroit Straight-Line Drive for the 2½-ton, 6 x 6 military truck is a vastly improved unit.

On Timken-Detroit axles... you go anywhere you gotta go... and with power and stamina. You can't be choosy in combat... and you can't afford breakdowns in schedules *or* the vehicle. And every day, continuous research is adding even greater performance to the 6 x 6.

knots

Timken has it!

Interchangeable Final Drive Unit—The same type of rugged Double-Reduction Final Drive, formerly used so successfully only in heavy-duty military trucks, is a feature of the Timken-Detroit equipped 2½-ton 6 x 6 truck.

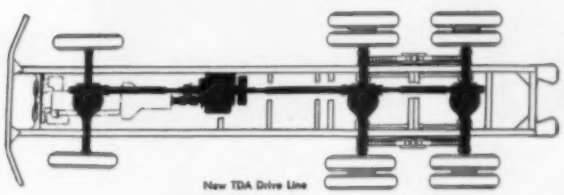
Gear reduction is accomplished in two steps giving increased torque and shock-load capacity. Bevel gearing is used for the first reduction and helical gearing for the second reduction.

What's more...

INTERCHANGEABILITY...

of parts for easier logistics

1. **A simpler logistics problem of stowage and palletizing.**
2. **Fewer different parts in stock bins—of vital necessity to military supply officer who must maintain a warehouse on wheels.**
3. **Far greater ease of maintenance.**
4. **Fewer records of parts and service operations to maintain.**
5. **Reduced personnel training time in operation and maintenance.**
6. **More personnel made available for other duty.**
7. **Faster availability between manufacture and use.**



New TDA Drive Line

Here's what makes the Timken-Detroit 6 x 6 assembly "tick"

The new design features a straight-line drive from the front axle through the transfer case to *both* rear axles. This is possible because top-mounted double-reduction final drives are used on all three axles. Ground clearance is increased... propeller shaft angles reduced vertically and horizontally.

This double-reduction final drive permits a gearing arrangement which makes possible the through-drive design. Power is thus transmitted in a straight line from the transfer case to the first rear axle and through this axle in a straight line to the second rear axle and likewise in a straight line to the front axle. This eliminates the need of pillow blocks and another set of propeller shafts and accomplishes a degree of interchangeability of parts that cannot be otherwise obtained.

Final drives in all three axles are *identical* and *interchangeable* and are easily removed from the housing for service.

TIMKEN Detroit AXLES

TIMKEN-DETROIT AXLE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
DETROIT 32, MICHIGAN

The Accepted Standard

TRADE MARK REGISTERED

Plants at: Detroit, Michigan • Oshkosh, Wisconsin
Utica, New York • Ashtabula, Kenton and
Newark, Ohio • New Castle, Pennsylvania

WEED PROBLEMS?

One application of

Du Pont Telvar®

WEED KILLERS

stops weeds for the season—or longer!

"Telvar" kills weeds through the roots . . . prevents regrowth. Low rates (20 to 80 lbs. per acre) make it cost little for the results you obtain . . . also mean less handling, fewer storage problems. To cut maintenance costs to new low levels, put "Telvar" in your weed-control program. Available in two formulations: "Telvar" W, and "Telvar" DW.

Note thorough job "Telvar" did around this fence. "Telvar" won't corrode fence or equipment, it's low in toxicity to humans and animals, non-flammable and non-volatile.

BRUSH ON RIGHT-OF-WAY?

Above—Right-of-way being treated with "Ammate." Below—Three years later, brush is still under control. "Ammate" allows low-growing cover to return to resist erosion.

One application of

Du Pont Ammate®

WEED AND BRUSH KILLER

kills more kinds of brush —safely—at lower cost!

"Ammate" kills more kinds of brush and keeps it down longer than most weed and brush killers! When the original spray job is done well, brush is kept under control for years with only an occasional spot spray. You can rely on "Ammate" to do the job safely, even where your right-of-way adjoins cropland, because "Ammate" is not volatile. There are no vapors to drift onto sensitive crops. It is no hazard to crews, stock or wildlife.

FREE ILLUSTRATED BOOKLETS describe how to control weeds and brush with Du Pont chemicals. For your copies, write to Du Pont, Grasselli Chemicals Dept., Rm. 4032, Wilmington, Del. In Canada, Du Pont Company of Canada Limited, Box 660, Montreal.

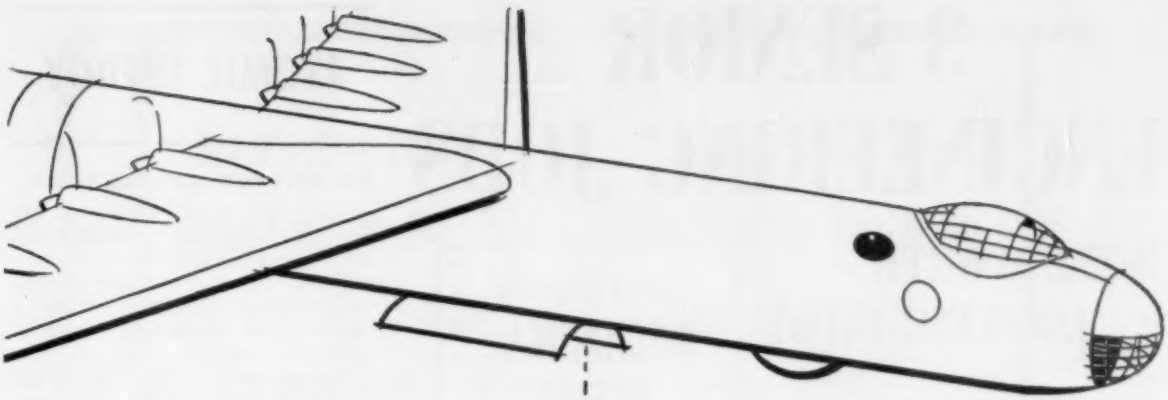
On all chemicals always follow directions for application. Where warning or caution statements on use of product are given, read them carefully.

Telvar® Weed Killers for industrial use

DU PONT REG. U. S. PAT. OFF.

Ammate® Weed and Brush Killer

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*



If you have to "drop a bomb in a barrel"...

Call AC!

A barrel makes a small target, but if anyone can hit it, AC can.

For several years now, AC has built complex Bombing Navigational Computers for our biggest bombers. And, because of AC's production engineering, these units are pounds lighter, inches smaller, and thousands of dollars cheaper.

This BNC, as we call it, is one of America's mightiest weapons. But, it is only one of many steps AC has taken to supply electronic answers to navigation, bombing and firing problems.

If you have a problem in this field, AC has the ability and experience to help you. Give us a call, won't you?

AC DEFENSE PRODUCTS

GM GENERAL MOTORS

AC SPARK PLUG DIVISION
ELECTRONICS DIVISION OF
GENERAL MOTORS CORPORATION,
FLINT, MICH.

Write for new AC booklet now coming off the presses, titled "AC . . . Engineering for the Future."

3 SENIOR ENGINEERING JOBS

WELL WORTH LOOKING INTO!

Senior Engineer
MECHANICAL DESIGN

6-10 years experience in missile or aircraft electronic package design. Familiarity with vibration and other environmental problems essential.

Senior Engineer
TEST EQUIPMENT DESIGN

7-10 years experience in development and design of electronic test equipment for complete systems involving microwave and pulse techniques, adaptation of commercial instruments to special applications, preparation of proposals and the actual product design of electronic and electromechanical devices. Familiarity with problems of maintenance helpful. Supervisory experience and ability required.

SYSTEMS PROJECT ENGINEER

6-10 years experience in missile or radar electronic system development. Ability to direct systems engineering at the project level.

Here are three especially attractive job opportunities for engineers who want to get on the ground floor in the important, interesting, and challenging phase of a new industry—guided missiles.

Qualified men are given real job responsibilities with Bendix and grow with the development of what is not only the nation's most important weapon system, but a project that will undoubtedly lead to new and important long-range commercial application.

At Bendix you will be associated with top missile authorities and have at your command unexcelled engineering and manufacturing facilities. Salaries for these top jobs and other opportunities are open for discussion. Write today to: Mr. W. L. Webb, General Manager, Missile Section, Bendix Products Division, Bendix Aviation Corporation, 403 North Bendix Drive, South Bend, Ind.

23 OTHER ENGINEERING POSITIONS!

Bendix also offers unusual job opportunities for assistant engineers, junior engineers, and technicians, as well as a score of other assignments. A 30-page book describing in detail every phase of our guided missile operation will be sent to you on request. If you are interested in guided missiles, this book will interest you. Write for it today.

ATOMIC ENERGY

GENERATOR AT COLUMBIA

The Atomic Energy Commission will install a Van de Graaff generator and auxiliary equipment at Columbia University and will contribute approximately $295,000 toward a laboratory to house the machine which will be used in research of interest to the AEC.

The generator, capable of accelerating particles to energies of six million electron volts, is being made by the High Voltage Engineering Corporation, Cambridge, Mass. Cost of the machine plus auxiliary equipment and installation will total about $450,000.

The installation of the generator at Columbia will mark a step forward in the Commission's program of nuclear cross-section measurements. The staff at Columbia University has been deeply involved in the measurement of basic nuclear properties and cross-sections since well before World War II. Through these efforts, which have been carried out under the direction of Prof. William W. Havens, substantial contributions have been made toward obtaining the basic nuclear data needed for atomic reactor and weapon design.

ATOMIC CONFERENCE

Preliminary plans have been made for participation by the United States in the International Conference on the Peaceful Uses of Atomic Energy at Geneva, Switzerland, August 8-20, 1955.

The United States Government has accepted the invitation to participate in the conference, which was extended by the United Nations to eighty-four nations, including ten from the Soviet bloc. Enclosed with the invitations were several documents, including the topical agenda for the conference and the conference rules of procedure.

Primary responsibility for the technical planning and preparation for United States participation has been assigned to the Atomic Energy Commission. The Commission has named Dr. George L. Weil, former assistant director of its Reactor Development Division and now a consultant to the Commission, as technical director for United States participation in the conference.

The conference is an outgrowth of the atoms-for-peace proposals laid before the United Nations on December 8, 1953, by President Eisenhower when he urged that the atomic resources of the world be mobilized to apply the benefits of atomic energy to the cause of peace.

The conference will be devoted to the presentation of information on reactor

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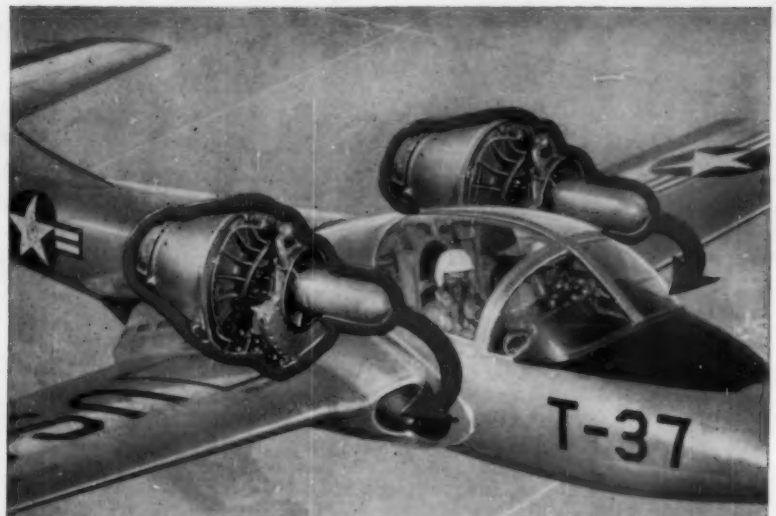

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•

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Atomic Energy

technology, atomic power, radiation protection, applications of atomic energy to biology, medicine, and agriculture, and the industrial uses of radioisotopes.

The Atomic Energy Commission is assembling through key United States educational institutions, industrial establishments, and Government and private research centers technical information in the fields appropriate to the agenda.

The Commission also is planning a technical exhibit at the conference site at Geneva. More than sixty institutions and firms already have signified interest in participating in this exhibit.

BRITISH POWER PROGRAM

A British Government White Paper recently announced a provisional plan for producing a substantial proportion of her electricity needs from nuclear power stations by 1965.

The program will cost in the region of $840 million and involves the building of 12 nuclear power stations with a capacity of between 1.5 and 2 million kilowatts.

The amount of electricity produced would be equal to that from 5 to 6 million tons of coal a year, a calculation based on the expectation that as much heat can be extracted from one ton of nuclear fuel as from 10,000 tons of coal.

Private industry will be given the task of building Britain's first A-power stations for the publicly controlled electricity authorities, who will own and operate them. Specialized training for the builders and operators of the new plant has already started.

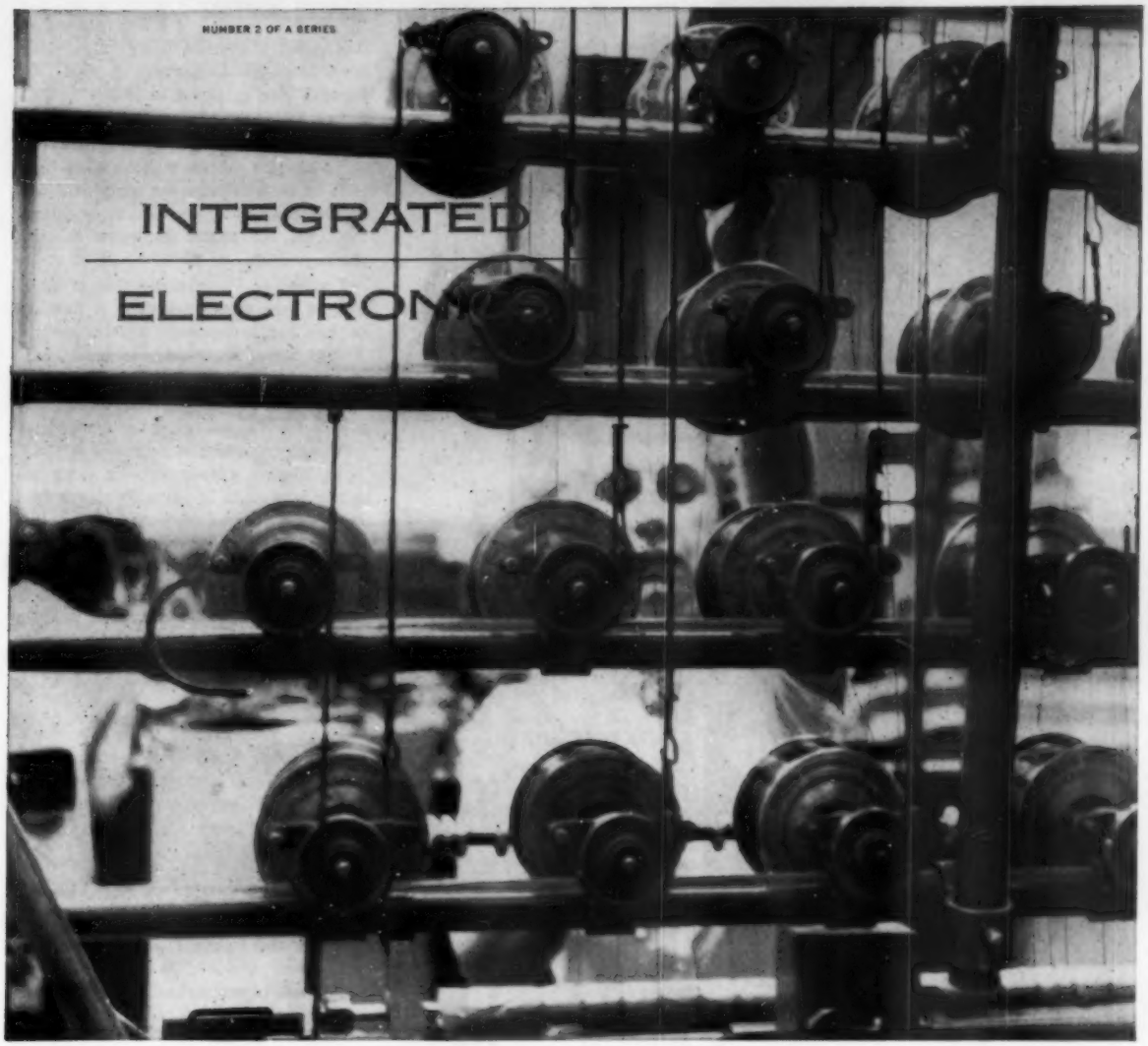
Many valuable lessons have been learned from Britain's first large-scale uranium atomic power station now being completed at Calder Hall in the north of England and expected to operate soon. The early stations under the 10-year plan will be commercial and improved versions of the Calder Hall prototype.

Cost of A-power electricity will be comparable to that produced in coal-fired power stations—about half a cent per unit. Moreover the first nuclear power plants, burning uranium, will produce not only heat but immensely valuable plutonium which can be used in more advanced stations as the program progresses. This "plutonium credit" will help offset the considerable cost of the scheme.

Building of the first commercial stations will start in 1957—the time lag being necessary for training atomic technicians. These early stations would be in operation in 1960-1961.

Phase 2 stations, of an improved type, would go under construction in 1958-1959 and come into operation in 1963.

Phase 3 would begin with construction of four still further improved plants in 1960 (coming into operation in 1963-



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1964), and four more using very highly rated liquid-cooled reactors in 1961-1962 (coming into operation in 1965).

The A-power plants will be absolutely safe, says the White Paper. There will be no need to site the stations away from built-up areas, though the early ones will not be constructed in densely populated localities. An atomic explosion in such plants is dismissed as "impossible."

The White Paper states that progress may be even more rapid than is forecast, or less rapid and more costly, but the British Government declares itself ready to accept these calculated risks.

The A-power stations are particularly urgent for Britain, since her demand for power is expanding rapidly and her coal production is not enough to carry the whole burden. In 20 years the demand for electricity in the United Kingdom is expected to be 3½ times the present level.

From 1965 onward it is envisaged that all new power stations might depend upon nuclear energy, and if all went well the total nuclear power station capacity by 1975 could be 10-15 million kilowatts—equivalent to the amount produced by 40 million tons of coal.

However, because of the rapidly growing need for power, the A-stations will supplement and not replace other forms of fuel, and coal mining will remain one of the major employing industries of the country.

INFORMATION AVAILABLE

The Atomic Energy Commission stated recently that medical and biological information developed by its scientists on the effects of nuclear radiation, blast, flash burns, and fall-out is made public as rapidly as it can be properly evaluated and correlated.

The Commission denied that the medical profession is refused access to the results of its studies of the effects of nuclear explosions on human beings and animals and methods for treating casualties.

It is the Commission's long-standing policy that the American people and medical science should be informed, as rapidly as possible, of the biomedical aspects of atomic energy.

A large amount of information of this nature has been made public, and the Commission's report of February 15, 1955, on the effects of high-yield thermonuclear explosions declassified much additional information.

The only biomedical data which remains classified are in piecemeal or incomplete form and therefore inadequate for use by the medical profession. As soon as such information is brought into comprehensive and helpful form it is published, in line with the established policy, the Commission stated.

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HON. CHARLES S. THOMAS
Secretary of the Navy

Firepower Afloat

Modern ships and weapons keep our Navy strong in the atomic age

"OUR defensive capabilities now are greater than ever before."

This is the view of Adm. Arthur Radford, Chairman of the Joint Chiefs of Staff, who recently listed the following key strengths which go into the make-up of our defense program:

1. Strong retaliatory capability. We have a long-range Strategic Air Command without peer in the world and carrier task forces unmatched by other nations.

2. Strong land, sea, and air forces which can be used in a variety of situations whenever and wherever required.

3. Strong allies. The pattern of our own forces conforms to that of a member in several great alliances.

4. Continuing improvement of our continental defense system. Both Canada and the United States are constantly improving their respective air defenses, radar, communications, and computing systems which will provide increased effectiveness against attack. Our neighbors to the south are important members of the team.

5. An unbeatable industry-science-military team. The services are organized to utilize our national scientific, technological, and productive abilities. Science helps to devise new weapons and new techniques. Industry helps to produce them.

THE threat of modern atomic warfare calls for constant modernization. The Navy's current billion-dollar shipbuilding program, for example, calls for the construction of a fifth 60,000-ton carrier, three atomic submarines, and a number of guided-missile ships.

The total program provides for the construction of twenty-four new warships and the conversion of twenty-eight older vessels for new rôles. Guided missiles are being strongly emphasized.

One of the new conventional Diesel-powered submarines included in the program and three new frigates will have guided-missile capabilities. One light cruiser and one destroyer will be converted to guided-missile use. Guided missiles are being integrated rapidly into the operating forces.

Before the end of the year our Navy will have four cruisers with guided missile launching capabilities in the surface-to-surface field. Two converted cruisers, the BOSTON and CANBERRA, both equipped to handle the Terrier missile, are due to join the fleet at the end of 1955.

Our Navy has four aircraft carriers which already have a guided missile launching and guidance capability, and nine other carriers which can handle air-to-air missiles for the aircraft squadrons attached.

An American experimental guided-missile submarine has been operating in the Pacific for many months.

Secretary Thomas told a congressional committee that "in the guided-missile field the Navy is just now crossing the threshold into a field which promises to revolutionize navies as much as did the discovery of gunpowder."

FORRESTAL-class carriers, giant floating airfields, are essential to control of the sea. They represent the Navy's portion of an over-all build-up of air power which has been determined to be basic to defense policy which we must pursue in the atomic age.

Mobile seaplane striking forces of great flexibility are now being planned to take advantage of the seakeeping capability of the Navy's new P6M. This Martin development is a true flying boat, jet-propelled, that can operate with the support of a few logistic ships as an advanced striking unit from any moderately sheltered waters.

Nuclear weapons reëmphasize the importance of sea power. There is no substitute for the strategic and tactical mobility which sea power provides.

In any future conflict our Navy would be required to protect sea areas vital to our own and allied interests. It would be needed to support our national commitments overseas.

Charles Sparks Thomas, whose photograph appears on the opposite page, became Secretary of the Navy on May 3, 1954. He previously served as Under Secretary of the Navy and as Assistant Secretary of Defense (Supply and Logistics).

Secretary Thomas was born in Independence, Mo., in 1897 and attended the University of California and Cornell University. During World War I he served in the Aviation Branch of the U. S. Naval Reserve Force.

At the conclusion of his naval service in the First World War Mr. Thomas joined the investment house of George H. Burr Company and in 1925 became a partner and vice-president.

In 1932 he became vice-president and general manager of Foreman and Clark, Los Angeles, retail clothing stores. Five years later he was made president, a position he held until his appointment as Under Secretary of the Navy.

During the Second World War Mr. Thomas was special assistant to the Assistant Secretary of the Navy for Air. He later served as an assistant to Secretary Forrestal.

For his outstanding wartime service Mr. Thomas received the Presidential Medal for Merit and the Distinguished Civilian Service Award.

New Aerial Weapons

The Martin Matador missile

Vern Haughland

PROGRESS in air armament over the past year and a half should be looked at in the light of various policy statements of the armed services. One significant pronouncement was that of Air Force Brig. Gen. Leighton I. Davis before the American Ordnance Association at Fort Worth last year. Said General Davis:

"Nuclear weapons have changed the nature of war in many ways. The total destructive power available is almost beyond comprehension—certainly enough to destroy all the world's industries many times. However, the next war may not necessarily be won by the nation that has the greatest stockpile of atomic weapons.

"The rapid delivery of these weapons against enemy air power and the protection of our air power against destruction is the key to survival. Our stockpile of bombs must be complemented by an Air Force in being, ready to go at a maximum delivery rate. It must be dispersed and protected so that if we *must* suffer another Pearl Harbor we can get up off the floor and retaliate with the speed and accuracy that will win."

General Davis declared that in a World War III the rate of destruction of air power by enemy action would be many times the rate of replacement by industry, and the rate of destruction of industrial capacity would be many times the rate at which industry could be rebuilt.

Thus, he said, as atomic stockpiles grow, the speed at which war is waged —becomes more important than the total lethality of the stockpile.

Mr. Haughland is aviation correspondent for the Associated Press, Washington, D. C. He is the author of "The AAF against Japan" and "Letter from New Guinea."

Security restrictions cloak much that is being done to match the increasing deadliness of weapons with swifter delivery against targets. The Air Force Armament Laboratory at the Wright Air Development Center in Ohio reports, for example, "many advances in aërial armament during 1954." But it adds, "Virtually all the significant work must be classified for obvious reasons."

AMONG aircraft which will project combat tactics into the high speeds and high altitudes of the immediate future are those of the Air Force's so-called "Century series"—the North American F-100, McDonnell F-101, Convair F-102, Lockheed F-104, and Republic F-103 and F-105—all supersonic fighters.

Probing for the more distant future are research or experimental models, such as the Douglas Skyrocket and the Bell X-1A. The latter has surpassed 2½ times the speed of sound.

In some quarters there are fears that research facilities are failing to keep sufficiently in advance of aircraft and armament development in some respects.

At the Naval Ordnance Test Station, China Lake, Calif., for example, a new heavy-duty, precision-aligned track, 4.1 miles long, is used for captive-flight testing of rockets, guided missiles, and model or full-scale airplanes; for fire-control system tests from aircraft flying above a carriageborne target having controlled supersonic ground travel; and for aëroballistic tests of projectiles or rockets fired or launched from the moving track carriage under simulated flight conditions.

FROM the Navy standpoint, the "biggest thing in Navy aviation in the past year" has been the development to "advanced status" of a supersonic air-to-air guided-missile system, the Sparrow I. The Navy permitted partial disclosure of the missile after more than seven years of development by the Bureau of Aëronautics and the Sperry Gyroscope Company during which more than one hundred prototype missiles were test-flown, incluuding air launchings from Navy aircraft since 1949.

The Navy withheld data on exact weight, (about 300 pounds), range (about 5 miles), type of warhead, and performance and said only that the Sperry Sparrow is rocket-powered and fully maneuverable at supersonic speeds, yet light and compact enough to be carried in multiple units by fighter-type jet aircraft.

It added that the missile types selected for first- and second-phase production runs at the new Sperry Farragut Corporation plant at Bristol, Tenn., are "systems capable of accurate control when the missile is fired from a speeding jet airplane."

One civilian expert employed by the Navy says the Sparrow "in many ways opens up a new era," because of the increase in range and lethality that it provides. He says that eventually the Sparrow and missile systems of its type will eliminate guns and fixed rockets because of the increased "kill probability" and because of the safety aspect.

Navy photographs show the Douglas F3D Skyknight, a twin-jet night fighter, armed with four Sparrows on wing racks, two under each wing. One version of the F7U-3 jet fighter, a radical tailless design, also is designed to carry and launch guided missiles.

LITTLE has been released on missile development generally, but recent compilations identify the following, at least by name:

In the air-to-air category, in addition to the various types of Sparrow built by Sperry, Douglas Aircraft, and Raytheon Manufacturing Company, are the Martin Oriole, large and long-range (1,500 pounds, 20 miles) Mach 3 missile developed for the Navy Bureau of Aëronautics; the Philco Sidewinder, also for the Navy; and the Hughes F-98 Falcon, a Mach 3 missile destined as armament for the Convair F-102.

In the air-to-surface category are the Bell Rascal, reportedly for use on large Air Force bombers such as the Boeing B-47 and the Convair B-36 and B-58, and the Fairchild Gorgon V, for the Navy.

Air-to-underwater missiles include the Fairchild Petrel and Eastman Kodak Dove, for the Navy.

IN the surface-to-air bracket are the Navy's Convair Terrier, which has been launched from the former battleship MISSISSIPPI, now a missile-testing ship; Bendix Talos, for the Navy and the Air Force; Martin Matador III, Boeing F-99 Bomarc, and the Swiss Oerlikon, for the Air Force; and the Douglas-Western Electric Nike, Bendix Loki, Raytheon Hawk, Chrysler Redstone, and General Electric Hermes for the Army.

The Oerlikon, which like most other missiles could carry an atomic warhead, is 16 feet long, about 3½ feet in diameter, weighs 545 pounds loaded, and

The Falcon, smallest guided missile in production, travels at supersonic speeds using a radar directional system (Air Force photo).

is designed to travel up to 850 miles an hour.

The Nike, with a range of eighteen miles, is regarded by some air experts of doubtful value against jet bombers, and one aviation writer has called its chief value to be "as propaganda for the Army and to keep Congressmen feeling safe."

Surface-to-surface missiles include the Martin B-61 Matador, of which the Air Force has two squadrons stationed in Germany; Northrop B-62 Snark, North American Navaho, and Convair Atlas, Air Force long-rang "intercontinental" missiles; Chance Vought Regulus, for the Navy; Cornell Aëronautics Laboratory Lacrosse, developed by Army Ordnance for close support of the Marines; Honest John unguided artillery rocket and Firestone's radio-guided Corporal, for the Army. The Redstone, in addition to its antiaircraft potentialities, can be classed as a ground-to-ground weapon, as can the Hermes.

THE Army says the Corporal, equipped with either an atomic or conventional warhead, can engage tactical targets far beyond the ranges of the new 280-mm. gun and the Honest John rocket. It follows a ballistic trajectory to the target, and is unrestricted by weather or visibility conditions. Its speed, produced by a powerful rocket motor, is several times that of sound.

Maj. Gen. James M. Gavin, Army Assistant Chief of Staff for Operations, has disclosed that newer weapons such as the Corporal and Honest John have been given priority over the 280-mm. atomic cannon. Cancellation of the atomic-cannon program would seem to indicate that the Army will depend upon guided missiles for delivery of atomic shells.

At Eglin Air Force Base, Fla., the Air Force Armament Center is making progress with Project "Gun-Val," set up in 1951 to speed development of newly designed foreign and domestic weapons installed in Air Force aircraft and to determine armament combinations capable of producing increased effectiveness.

The Gun-Val Committee, with members representing Wright Air Development Center, Air Matériel Command, the Air Proving Ground Command, and the Armament Center, has divided the weapons testing into these phases:

1. Reliability—The number of rounds of ammunition fired per stoppage and the probability of firing a full load of ammunition.

2. Usability—Problems of maintenance of a weapon or combination of weapon and aircraft, barrel life of a weapon, firing schedules.

3. Effective firepower—The number of hits to be expected on a target from an installation for a given period of time or number of rounds fired.

The Armament Center says that more than half a dozen Gun-Val projects have been completed. "So far, gun-aircraft combinations have been centered around fighter-type aircraft, although bomber tests have been made," a Center spokesman reports. The results have not been made public.

However, the Center says that the North American F-86 Sabrejet underwent combination tests in an effort to improve its effectiveness with new and improved weapons, one of them being a foreign-made Oerlikon 20-mm. gun. Northrop F-89 Scorpions were tested with the 30-mm. Oerlikon gun. Lockheed F-94 Starfires were tested with two different types of guns.

One product of Gun-Val, combat-tested by the Air Proving Ground Command in F-86F's in Korea, was the new 20-mm. automatic aircraft gun M39. In the short time that it was in combat the gun accounted for the destruction of 6 Russian-built MIG-15 fighters, the probable destruction of 3, and the damaging of 12.

The Air Force described the M39's rate of fire as "fantastically high—considerably higher than for any aircraft gun now in operation." It added that the gun was developed for use in the latest combat airplanes, "including transsonic and supersonic aircraft."

Pilots reported it far superior to the conventional caliber .50 machine gun, which fires at the rate of 1,200 rounds a minute. The Communist MIG in Korea was armed with one 37-mm. and two 23-mm. cannon as against the six machine guns on the F-86E, F-86F, or F-84G, and thus packed more destructive power—but at a much slower rate of fire.

The M39 was developed in response to the desire of pilots to have a larger caliber gun without sacrificing the advantage over the MIG in the field of rapidity of fire. The Air Force called the new gun a product of the close teamwork existing between it and private industry and the U. S. Army.

The gun, weighing about 170 pounds, throws a shell which bursts after penetrating the target. Its high-firing rate is made possible by the 5-chamber, revolver-type cylinder which moves ammunition through the feeding, firing, and extracting phases at a greater rate than a reciprocating-bolt type mechanism.

Another new aircraft weapon with the code name of Project Vulcan, also a 20-mm. firing mechanism, has a rate of fire surpassing even the "fantastically high" description of the M39. It has become known as the "Gatling gun," after the famous Civil War weapon, because of the probability that it uses a revolving multibarrel assembly.

General Electric Company, manufacturer of the Vulcan, also has developed a new fighter gun sight system, the K19, considerably lighter and with fewer parts than other sights currently in use. The K19 is part of a system which includes the aircraft autopilot, computing elements, and the gun sight itself.

THE standard attack for day fighters, the lead pursuit approach, is the basic attack considered in the K19 design. In such an approach, the computer gives the pilot information visually to enable him to lead the target by the proper amount. An interlock prevents firing until the target is in range.

For the lead collision approach, which is favored by night fighters, the pilot centers the target in his sight. The sight, autopilot, and radar keep the airplane on the computed course. The sight system fires the guns automatically at the correct range, and then

breaks off the attack to avoid collision.

The day fighter, armed with fixed guns, must head continuously slightly to the front of the target, and therefore must fly a curved course, the "lead pursuit curve," in order to keep his guns trained on the target long enough to pour in the firepower to bring the victim down. This form of attack is comparatively hazardous because of the cone of fire from the tail guns of a heavily defended bomber.

An all-weather or night interceptor such as the F-86D, however, equipped with a computing machine to fire its rockets automatically at the moment at which they will intercept the target, need be on the target for only an instant. Thus he flies a straight-line collision course only until the rockets fire and so becomes virtually invulnerable to the bomber's defense. The bomber's guns must fire crosswind at a target with a rapidly changing bearing and have comparatively little opportunity to inflict a hit.

THE F-86D, America's first one-man, all-rocket-armed jet interceptor, packs twenty-four "Mighty Mouse" 2.75-inch rockets, and can salvo them with amazing accuracy. It can search out and shoot down an enemy that may never be seen except as a "blip" on the radar scope. A single hit from just one rocket is sufficient to destroy the largest bomber.

The F-86D packs its rockets in a retractable pod which pops out from the plane's fuselage. Immediately after firing, the pod snaps back into the plane to provide a streamlined surface for near-sonic flight.

The Air Force announced last September that it has ordered a sixth model of the Sabrejet series, the F-86K, as a cannon-firing version of the F-86D. The aircraft had to be lengthened eight inches to accommodate the new armament—four 20-mm. cannon—which replaced the twenty-four rockets. Another new Sabrejet, the F-86H day fighter, is armed with six .50 caliber machine guns.

THE Mighty Mouse is a husky piece of armament which packs the punch of a 75-mm. cannon and streaks toward its target at supersonic speed. Its manufacturer, Hycon Manufacturing Company, Pasadena, Calif., delivered the one millionth "Mouse" to the Armed Forces late in the autumn of 1954.

While the F-86D carries twenty-four of the 2.75-inch rockets, the Lockheed F-94C carries just twice that load—forty-eight Mighty Mice. And the Northrop F-89D packs a really terrific wallop—104 of the folding-fin devices.

General Electric displayed its new remote-controlled tail turret system for high-speed jet aircraft publicly for the first time at the National Aircraft show in Dayton last September. Currently installed in the Boeing B-47 medium bomber, the system gives the 6-engined Stratojet a heavy rearward punch.

The system consists of a tail turret mounting two 20-mm. radar-controlled cannon, an electric computer, a search-track radar and control equipment. It enables the B-47 to shoot down an enemy airplane as readily in fog or darkness as in daylight.

It works this way: an enemy approaching from the rear appears as a bouncing jag in the straight green line crossing the face of a circular radar screen. The operator centers this nervously jumping part of the line, this elongated pip, in cross hairs and then switches from search to track—meaning that the guns will remain automatically trained on the object which causes the pip.

THE radar signal also is fed through the electronic "brain" to provide it with equational information from which the point where the attacking aircraft will come into range is calculated. As that point is reached, the guns are fired.

Other advances in the general field of aërial armament include:

1. Use of the rotary bomb bay door on the Martin B-51 light jet bomber.
2. The announcement of several improved types of bomb hoists.
3. Release of information on the launching equipment for the Martin

The Army's Corporal guided missile can find its target despite weather or visibility conditions and has a range greater than that of the 280-mm. gun (Army photo).

B-61 Matador missile—the "zero-length launcher" which, set on a special semi-trailer, operates in an area only one hundred feet square, without the use of a runway.

The Matador, resembling a small jet fighter, is mounted on the launcher by a 3-point suspension. Two ball-and-socket supports at the front point the weapon upward at a 15-degree angle. The rear support is a bolt which holds the Matador stationary until full power is reached, at which time the bolt shears and allows the missile to take off.

4. Award of an Air Force contract for construction at the Arnold Engineering Development Center, Tullahoma, Tenn., of a high-altitude armament test cell to determine what happens to different types of high-explosive shells fired at high altitude and high speed.

THE cell will provide wind-tunnel test provisions for incendiary and high-explosive shells fired through a subsonic air stream of about Mach .85, or just below the speed of sound, into a typical wing section of an airplane.

Altitude conditions up to 60,000 feet, with a temperature range of from 90 degrees below zero Fahrenheit, to 160 above, will be created in the test section.

5. Air Force testing of a new type of fighter armament, the T-110 rocket launcher, on its most heavily armed fighter, the Northrop Scorpion. The launcher consists of two T-110 automatic rocket guns in the forward nose section. The Air Force said tests proved that the new air-to-air weapon was "compatible" with the Scorpion and highly effective from a firepower standpoint.

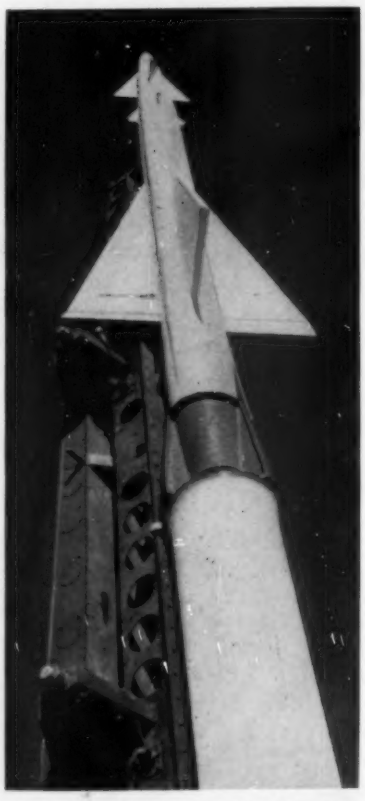
It added that the Scorpions were used merely as flying test beds for the rocket launcher and that no production use of the armament was planned for the F-89 fighter.

6. Development by the Air Research and Development Command of a new fixed-gunnery trainer, a classroom device for teaching fighter pilots the tactical use of a modern fire-control system. Designed and manufactured by Rheem Manufacturing Company, Philadelphia, the new device is known as the F-86D/F-151 fixed-gunnery trainer and consists of a conventional flight simulator, fire-control system, spherical screen, target image projection system, and instructor's console.

It uses a television pickup and projection system to portray a realistic simulation of air-to-air and air-to-ground targets, and maintains a continuous true-to-life spacial situation between interceptor and target regardless of course, speed, or type of maneuver.

7. Development by Goodyear Aircraft engineers of a radically new and improved winged tow target for gunnery practice at high altitudes. The 1,400-pound, all-metal target with a 25-foot wing span can be towed at speeds of more than 500 miles an hour, as much as 2 miles behind its medium jet bomber tow plane.

The target can be made to perform evasive maneuvers either automatically or by direct control from the tow plane, and can be offset to one side of the tow plane to permit closer simulation of a jet fighter "pass." A special device releases the tow cable the moment the target touches the ground, making possible repeated use of the equipment—an important saving in time and money.



A Nike guided missile is placed in firing position on its launcher (Army photo).

8. Announcement by the Navy of the development of a "parachute target" impregnated with metal to provide radar reflectivity. Fired by a rocket to high altitudes, the parachute provides an inexpensive and long-lasting target for guided-missile crews seeking to locate and shoot it down.

RYAN builds a jet drone missile—known to the Navy as the Firebee, to the Air Force as the Q-2, and to the Army as the XM21—capable of simulating attacking enemy aircraft at speeds of around 600 miles an hour and at altitudes of up to 40,000 feet. Flown by electronic remote control from a ground station, the Firebee also has the radar reflectivity required in order to simulate a high-flying jet bomber.

Ryan pointed out in a news release that targets which have been used for crew training and weapons evaluation in the past—200-mile-an-hour towed sleeve targets, small radio-controlled aircraft with gasoline engines, and obsolete planes converted to drone operation—have proved unable to simulate the speed, altitude, and performance of attacking jet craft.

The Ryan jet drone missile can be launched from "mother" planes in flight, or from the ground. It has a span of 12 feet, is 18 feet long, weighs 1,800 pounds, and is powered by either a Fairchild J-44 or a Continental-Marbore J-69 jet engine developing 1,000 pounds of thrust. The Army currently is using its XM21's as targets for the Nike weapon and for training crews operating the new radar-controlled Skysweeper antiaircraft gun.

This has been a summary of announced or generally known developments in the air-armament field. The real and full story of steady progress, in all its details, remains to be told. Until it is certain that potential enemies have fully informed themselves, or until the importance and significance of a particular development has been dissipated by time and by newer developments, that story will remain hangared in secrecy.

Careers in Ordnance

The Corps is developing a program which provides both competition and incentive and offers better opportunities for training and advancement to the military and the civilian career ordnanceman

Mark S. Watson

BEFORE Maj. Gen. E. L. Ford retired as Chief of Ordnance of the Army he initiated a service-wide inquiry into how an orderly career-planning program for civilian personnel could be developed. The purpose was to:

1 Provide incentive for the most promising of those men.

2 Improve *early in their careers* their capabilities and hence their chance of advancement.

3 Make available to these ambitious men information about prospective vacancies at a higher level, for which they qualified.

4 Similarly inform district, depot, arsenal, and other executives of the immediate availability of such men.

Should those purposes be achieved, it was manifest that other good results would inevitably follow, to the benefit of the individual civilian at whatever General Service level, to that of the executives in installations thus affected, and certainly to the efficiency of the Ordnance Corps itself.

THE task which General Ford, in the closing months of his active duty, was unable to push to completion, his successor, Maj. Gen. E. L. Cummings, promptly took in hand, at each stage of progress winning for his project the endorsement of Lieut. Gen. Williston B. Palmer, Chief of Logistics, and the approval of John Slezak so long as he remained Under Secretary of the Army.

Maj. Gen. E. S. Gruver, as Deputy Chief of Ordnance, showed the same lively interest in the project that he had previously felt as executive to General Ford, and it is manifest from the command decisions made at his level by Maj. Gen. J. H. Hinrichs (Field Service Division) who originated the staffing policy for his depots, and from the suggestions of Brig. Gen. J. Bruce Medaris (Industrial Division) that the zeal of General Cummings has been matched by that of his assistants.

Mr. Watson is a member of the staff of the Baltimore Sun and a well-known military analyst. He is the author of several books and holder of the 1945 Pulitzer Prize for international correspondence. Mr. Watson is a regular contributor to ORDNANCE, *his most recent article being "Our Navy, 1955-1975" which appeared in the November-December 1954 issue.*

It is just short of a year since General Cummings issued his directive of May 25, 1954, on "Establishment of Ordnance Corps Civilian Program for Storage Personnel." That is, the storage field was selected for the key mission, through whose experience in design of a policy, and of a pattern to fit the policy, it was reasonable to expect that a standard broadly applicable to the other divisions of Ordnance could be set up.

It is gratifying to report that today the staffing policy is designed and approved, and the pattern itself is so well advanced toward full implementation that it went into effect in the Storage Division last month.

It is equally gratifying to report that, independent of the civilian career enterprise, there has been under an older and more familiar program a continuous scrutiny of what can be done to help the careers of Ordnance officers and enlisted men, visibly producing a more orderly development in that field and singularly in harmony with the civlian project.

The numbers affected, relatively, are of interest. Civilian personnel (ranging from GS Grade 3 to Grade 15—but in this incentive program including, rather, Grades 5-15, with annual wages ranging from $3,410 to $10,800) at the March report numbered 113,525.

Officers in comparable assignments (that is, omitting Ordnance officers overseas, in continental armies, and otherwise not under direct control of the Chief of Ordnance) numbered 2,189, and enlisted men similarly assigned, 7,367. The civilian force's large dominance in numbers is something like twelve to one, which itself points to the great desirability of finding the optimum policy and pattern for career incentive for that huge majority.

At this stage a few words on basic principles of officer assignment will be useful. It is pointed out by Col. D. E. Breakefield of the Military Personnel Branch that there is now a recognized division of the Ordnance officer's first twenty years into three periods.

The first three years, spent on troop

Trained civilian specialists like this technician, shown plotting the course of a simulated Nike firing, are invaluable to the development of better ordnance.

assignments and in branch schools, are thought of as the period of military development; the next ten years as ordnance development (including the mastery of the assigned specialty); the next seven as command development, when the officer has reached a commissioned grade entitling him to assignments in which he must know much more than his particular specialty if he is to exercise a higher command competently.

IN a typical case, then, Lieutenant Blank will spend his fourth year as an officer at Aberdeen Proving Ground. Years 5 and 6 may find him a graduate engineering student at, say, Purdue University. Years 7-9 are a stabilizing period of specialized duty; if he is to be an ammunition officer, he may be at Picatinny Arsenal.

By that time Blank is overdue for duty with troops or staff or both and will perhaps go overseas for years 10-11. Then, if fortunate, he will get for year 12 a Command and General Staff School assignment (he must get that before he has had 15 years' service).

Year 13 (the last of his "ordnance development" period) would probably be the first of 3 years at a depot or in the Office of the Chief of Ordnance, so that he there begins his transformation, adding to his specialty a broader knowledge of administration and command over many specialties.

Having completed fifteen years altogether and proved his competence, Blank could now be sent to the National War College, the Army War College, or the Industrial College (again time is running against him, and if he ever is to reach one of these schools he must do so before he has finished his twentieth year in service—so that the advanced schooling will fit him for command before he is 45).

Again he is ready for his overseas tour, say in years 17-19, and in year 20 he should be fully set for command.

It cannot be expected that under the most perfect staffing policy this methodical procedure can be duplicated for civilian personnel, where both in job requirement and in personal fitness there is bound to be a very wide variation. Nevertheless, just as the Ordnance officer is expected to develop steadily, and the Military Personnel Branch has its career-organization supervision techniques for bringing that to pass, so the ambitious and competent civilian is entitled to somewhat similar supervision with a view to speeding his useful development and to making his talents readily available to the Corps.

IF the method with the officer were applicable to the civilian, General Cummings' task would have been easy. Patently that method is not applicable, and a great deal of time and effort has been expended to find one that is.

Many hands have been at work on the enterprise besides the general officers hitherto mentioned. Theories have been set up, tested, and rejected or revised or tentatively approved to permit testing of the next step.

The fruits of all this are already visible in graphic form in the Pentagon office of Truman G. Benedict, who since 1952 (when these first troubled inquiries got under way) has been attached to the Ordnance Executive Office as a guide and adviser, possessed of a profound understanding both of General Cummings' basic aim and of the means thus far developed for attaining it.

Because the Storage Division was given the lead, a report of progress will have to be illustrated by references to the way in which theory is applied in that part of Ordnance. What are we after, then, when we aim at a career program?

FOR example, suppose we seek to develop managers of ammuntion storage who will have a full knowledge of all the requirements of that job and experience both in what to do and what not to do and the mature judgment which a competent manager must pos-

sess. A young man headed in that direction, then, will have to go through three levels of training (note that the Ordnance officer did too). At the junior level he has an apprentice's opportunity to acquire a broad familiarity with all in sight. At the intermediate level he specializes and becomes competent in the specific areas of ammunition storage. At the senior level he broadens again, slowly gathering confidence and competence for management which must have cognizance of matters extending beyond a specialized field. That, then, is typical of what should be offered in a program for career advancement.

HOW is the program designed? It has four interrelated aims, thus, to:

1. Provide all present employees (and the outside public) with information about opportunities, to add incentive.

2. Provide appropriate means of screening and then developing each promising trainee as he comes in, by both on-the-job training and off-the-job schooling.

3. Maintain a central records file which will have a detailed report of (a) opportunities present and prospective, and (b) qualifications of individuals who, by their voluntary registration and indication of interest, seek advancement. (Compulsion in this field is neither practicable nor desirable.)

4. Select the candidate for the job on the basis of proved individual capability.

This was found to be reasonable enough, but no procedure could be undertaken until there was an assembling of information about the existing structure of the Storage Division (the willing guinea pig for an inquiry which would one day produce relevant information on the entire Corps and a scientific evaluation of that information).

General Ford himself was convinced by observation that the system of his day failed to give sufficient encouragement to civilians and to get maximum potential value from them. If there was a career program for doing all that in the case of the officer, should there not be one of those far-more-numerous civilians, too?

He pointed out that in his tours of installations he was likely to find, performing identical functions, ten military officers and five civilians in the top executive positions, or five military and ten civilians, or almost any other combination—an all-civilian staff below the officer in charge, or under a chief of division an officer and a civilian assistant of equal authority and hence two parallel lines of accountability.

Mr. Benedict's survey disclosed five different patterns. Today there is one pattern for a depot of over 3,000 and another pattern for a depot of under 3,000, but they differ only in the identity of one assistant in the whole complex staffing arrangement.

SIMILARLY, staffing patterns appropriate to each mission have been set up, with a uniform arrangement as to an officer or a civilian filling each post. (There is, of course, a recognition that the installation commander, faced with any of a dozen emergencies not in the schedule, can and must make an appropriate departure from the pattern until the emergency is over.)

The arguments which brought General Hinrichs' plans into this pattern were such as to make vivid and endlessly helpful certain concepts which can be presented in terms of dimensions.

Broad qualifications are expected in the military, as against the *deep* specialist qualifications of the civilian. The officer is assumed to be broad in his geographical knowledge by reason of widespread assignments; broad in his knowledge of diverse functions, including research, purchase, maintenance, etc., and in his acquaintance with depots, districts, arsenals, etc.; broad in his personal knowledge of the combat requirements for the matériel he is handling; broad in his knowledge of the Army as a huge, well-integrated system.

THE civilian, on the other hand, is expected to have a depth of knowledge of relationships in the installation and community and of local procedures; a depth of knowledge about administrative continuity—an historical knowledge, in a sense—and a depth of specialist ability.

The officer is expected, then, to provide the qualities in one grand dimen-

A guided-missile technician, an Army Ordnance proof officer, and a German scientist discuss the V-2 ground controls before firing a test rocket.

sion and the civilian those in the other, each to the other's benefit.

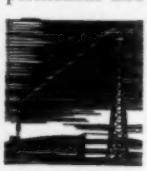
One can see the mutually reacting aspects of the patterns being devised and the programs arranged to suit them. The pattern (as previously indicated) identifies for the aspiring civilian the opportunities for his development; the program produces the talent to meet the staffing needs which are laid out in the pattern.

THIS has brought about a broad policy for integrated activities designed to find the promising candidate and give him a maximum chance to improve himself and benefit the system. It devises the means of selecting a career-service trainee by attracting promising candidates, selecting from them annually the required number to whom intern-type training can be given, and thereby furnishing replenishment of Ordnance personnel at junior levels.

They are rotated in assignments and, when appropriate, given off-the-job educational advantages. As they develop, their qualifications are noted on a Corpswide record file so that there can be a referral of meritorious individuals to all installations where there are vacancies, at which point the local commander can make intelligent selection from the several available candidates.

Beyond this, there is a monitoring of the growth and development of career personnel. This includes provision for carefully planned training and schooling, if called for, at an advanced level in order to produce as early as possible those who are best qualified for key posts.

The advantages of a permanent and Corpswide record of civilian personnel, with detailed knowledge of qualifications, are numerous. The promptness with which vacancies may be quickly and satisfactorily filled under the referral system is an advantage which no harassed depot manager will question and which is equally clear to a worried individual employee.



But one must stress the relationship of this sureness of knowledge to the continuity of operations. There is a great up-and-down movement of civilian employee totals, although the leveling-out program which has been so wisely designed in the Defense Department these recent years gives promise of eliminating some of the appalling peaks and valleys of the past. (When the demobilization of World War II had run its course, the Detroit Ordnance District had dropped from 7,952 personnel to 52.)

Even so, under the best of over-all planning there will be days when a civilian force (or a military) must be sharply reduced. The aim is to do so more scientifically than in the past, through identifying clearly in advance the solid core of first-class men on duty.

Then, when the enforced reductions come, that solid core can be kept on duty by the referral system and only the less-promising personnel dropped, perhaps never to find the path back to Ordnance. Men must be dismissed, but the aim (and now the possibility) is to avoid dismissing either the proved best or the juniors who promise in time to become the best.

"In this whole process the selection tends to be largely automatic. The ambitious and competent employee looks at the career opportunities above him; the employer looks at the talent requirements and the evidence of who can fill them."

In this whole process the selection tends to be largely automatic. The ambitious and competent employee looks at the career opportunities above him; the employer looks at the talent requirements and the evidence of who can fill them. There is an encouragement to competition, but there also is a way to provide incitement to compete.

Skeptics originally said that a civilian employee—settled in work at a depot, with local and family connections, with house and furniture bought—would not move to a distant depot, even if he knew he could get a better job. Experience shows he will.

But is he the man that the depot manager wants to apply for the job? The central qualification file will produce a lot of men so disposed and so qualified, and the depot manager can make an informed choice.

Perhaps by this time it will be clearer why a uniform staffing pattern is desirable, for that was another point on which there once was skepticism. Such a rigid system is not desirable just for the sake of uniformity, but it is the way in which to establish standard norms and the way which furnishes a guide to over-all planning and to provision of incentive. It seems to be the way to meet the exact needs of a job with the exact experience of a man and hence in the end to permit a saving of spaces.

It is not yet clear whether the uniform staffing pattern will call for more or fewer military in the several areas—depots, districts, Office of the Chief of Ordnance, arsenals, commodity commands, proving grounds, laboratories, research, and development. (The inquiry is proceeding in that order.)

But by July the decision will be made with regard to several, and by October with regard to all, and a full staffing policy can be stated. With this, the programming is coming apace, affecting supply specialist, ammunition inspector, acceptance inspector, civilian personnel technician, engineer (design, construction, maintenance, mechanical, chemical, electrical, etc.) accountant, management specialist, and industrial procurement specialists.

THE supply specialist came first. In a few months 300 candidates for advanced training had volunteered. Today the full design is under study preparatory to asking approval. The first interning will begin in early summer.

The military itself can learn from this something about the civilian supervisor's technique. A lieutenant colonel, chief of a general supply storage division, remarks that he has been on that job for eight years, and the time is near when he must be coming up to a higher position, calling for administrative knowledge of other specialties than his own—and he will not be ready. Under the new system he would be.

Progress in Sea Power

Recent developments in aircraft and aircraft carriers, weapons and detection devices for antisubmarine warfare, and guided missiles assure the Navy's continuing rôle as our first line of defense

Rear Adm. W. G. Switzer

Admiral Switzer is chief of Naval Air Training, Naval Air Station, Memphis, Tenn. This article is based on an address given by Admiral Switzer before the Birmingham Post of the A.O.A.

SINCE we as a nation are forced by circumstances not of our own choosing to maintain more than 3,000,000 men under arms for national defense, the importance of equipping them with superior weapons needs no elaboration.

Since the A.O.A. and the Navy are so closely aligned in a common effort toward the defense of our Nation, it would be appropriate to consider the Navy's rôle in that effort, its mission, its equipment, its personnel, and what it is doing to keep abreast of modern warfare in this jet-atomic age.

First of all, the basic rôle of the Navy is to guarantee freedom of the seas in peace and control of the seas in war, and in war this means the air over the seas and the water underneath.

Any strategic or commercial map of the world shows the land masses linked together by a network of lines which mark the ocean routes and sea lanes over which the commerce of the world travels. Control of these worldwide sea communications means control of seventy per cent of the surface of the world. Control of these sea lanes means we can project our naval striking power overseas, transport our men and materials to our bases overseas, and maintain and protect them there.

UNLESS we control the seas in wartime, vital strategic materials may be denied us and our most powerful of all weapons, our industrial power, cannot be brought to bear against an enemy. While control of the seas is no guarantee of victory, loss of it will certainly guarantee defeat.

In an uneasy, half-peaceful world where foreign policy and decisions are so largely based on military power, the ability to concentrate sea power quickly at the point where it is needed becomes the vital but very difficult rôle of our Navy. No routine peacetime deployment of our operating forces will do, and this vital task falls to our operating forces. Consequently the bulk of the Navy's striking power is now permanently deployed far from our home shores.

The major part of the Pacific Fleet's combatant forces, the Seventh Fleet, operates in Japanese, Philippine, and Chinese waters, and the remainder is preparing to sail for these waters when needed.

The Atlantic Fleet is similarly deployed in the Mediterranean and Northeastern Atlantic waters. Any one who has watched the tide of Communism being steadily stemmed and thrown back in the lands bordering on the Mediterranean during the past five years will realize the vital rôle played by the U. S. Sixth Fleet in this cold-war defense of the free nations of the world.

The striking power of these far-flung fleets lies in the attack aircraft carriers, with their air groups, around which the fleets are formed. In addition, squadrons of Navy patrol aircraft are deployed continuously in Alaska, Japan, Guam, the Philippines, Newfoundland, Iceland, the Azores, North Africa, and the Mediterranean. These are our shore-based antisubmarine forces.

Thus we find the Navy in her traditional rôle in the first line of defense ready and able to project her air sea power against the enemy far from our shores.

IT is the carrier task force which assures our Navy's control of the sea and the air above. At sea there can be no separate air force and sea force. They must be integrated in one force so that our sea power is in reality air-sea-undersea power.

To supply and maintain these distant combatant forces, hundreds of auxiliary vessels are required. Repair ships, tankers, supply ships, tenders, and transports are needed by the hundreds, and many of these are also deployed overseas. To give some idea of the effect this so-called cold war has

had on the Navy—just before the Korean conflict started the Navy had about 450 vessels in commission; now there are over 1,100.

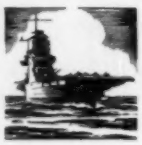
With all this global deployment of forces, you may be sure that the Navy is carrying its proportionate share of morale problems among its personnel due to the long-enforced separation from families and homes.

While the seagoing Navy is patrolling the vital sea lanes of the world and parading its might where necessary as a discourager of Communist aggression, the Naval Shore Establishment is backing it up with a program of new ship building, ship modernization, development of new weapons, and new equipment.

I WANT to mention particularly three fields in which new developments have made markedly successful progress: (1) aircraft and aircraft carriers, (2) antisubmarine-warfare weapons and detection devices, and (3) guided missiles. Progress in these three categories was and is vital to the Navy's future.

With the exception of antisubmarine and long-range patrol aircraft, the Navy has almost completed the transition to jet aircraft. There are practically no more propeller-driven attack carrier aircraft coming off the production lines. To provide adequate landing facilities aboard carriers for these new heavy and fast-landing jets, carrier decks have had to be strengthened, arresting gear redesigned, and catapults replaced with more powerful ones.

This has been and is a tremendous task which had to be undertaken in increments in order that the number of operating carriers would not be reduced.



First the decks were strengthened and the arresting gear replaced. The next step is the provision of the angled flight deck and the steam catapult. In a few short years the entire force of operating carriers will have all these improvements which will make it possible to operate with maximum ease and efficiency the larger and heavier the carrier aircraft of the future.

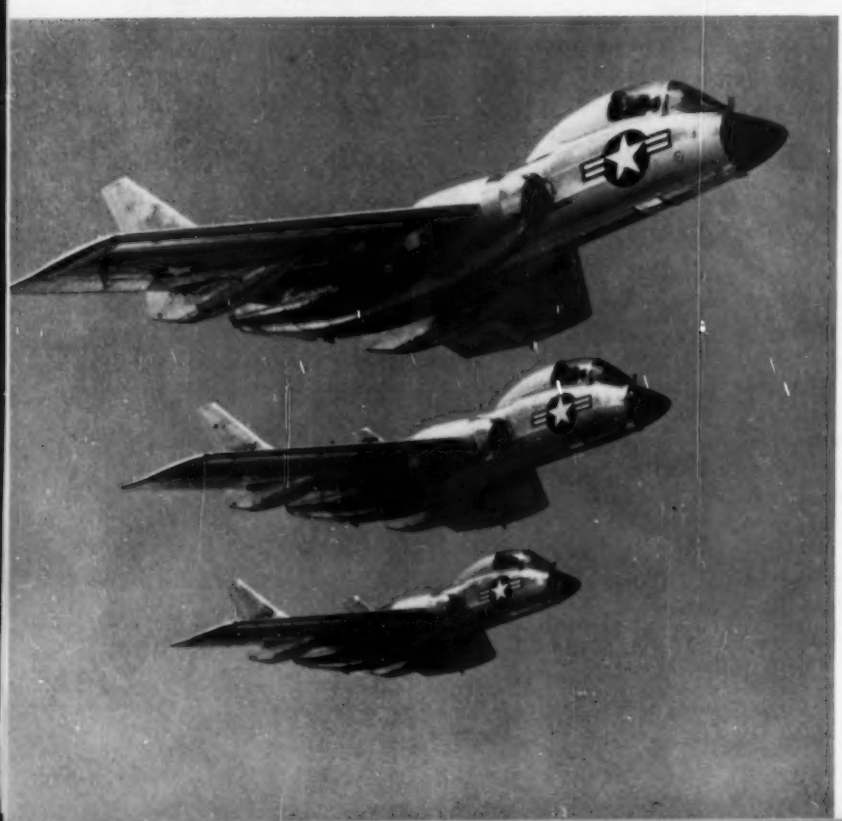
As an example, the U.S.S. FORRESTAL, recently launched at Newport News, will join the fleet in the fall of 1955. The FORRESTAL incorporates all the newest changes in carrier design including the new canted deck and four steam catapults.

Aircraft coming in on the canted deck land at an angle of eight to ten degrees to the left of the center line of the ship rather than down the center of the flight deck. Thus the pilot can take the air again, in case he fails to catch an arresting-gear wire, without endangering launching operations forward. With this flight-deck arrangement, launching and recovery operations can be carried on simultaneously. Thus, capacity for launching has been doubled, with twice the catapults, and flight-deck capacity more than doubled.

The FORRESTAL design also reflects the latest attention the Navy is paying to the problem of habitability for the crew. She is air-conditioned throughout, living space per man has been increased, and there are more showers and better messing and berthing spaces, increased laundry facilities, and improved semiprivate bunks —each with a reading light and redesigned lockers. Those who know something about living conditions on our ships can appreciate this "new look" in the interior of a man-of-war.

Proponents of naval aviation and aircraft carriers have long wanted such a ship as the FORRESTAL to replace the ESSEX-class carriers, work horses of World War II and the Korean War. Now with the SARATOGA, RANGER, and one as yet unnamed we will soon have four abuilding. These new ships will greatly increase the striking power of our fleet and will permit a wide range of new weapons to be carried and launched from our naval aircraft.

The new carrier-based fighter, F7U-3, is armed with 2.75-inch Mighty Mouse rockets, can carry guided missiles, and has a speed in excess of 650 m.p.h.



WITH 60,000 tons' displacement, 1,036 feet over-all length, over 200,000 horsepower, the latest and finest of propulsion machinery, ship controls, radar and communication equipment, and protection against bombs and torpedoes—these magnificent ships will testify to the fact that the Navy is not standing still and that carriers are here to stay, Field Marshal Montgomery to the contrary notwithstanding.

In the field of guided missiles, the Navy again has moved definitely forward. At the present moment there are three different types of guided missiles at the production stage and being introduced into the fleet. First is the Ter-

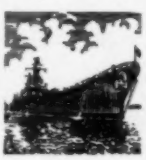
rier—a surface-to-air missile designed to be launched from a ship or land installation against airborne targets—aircraft or missiles.

The first shipboard launchings of Terrier were conducted in September 1951 from the U.S.S. NORTON SOUND, a converted seaplane tender now serving as a guided-missile test ship. Later, in November 1952, the old battleship MISSISSIPPI, modified to receive a service-type launching installation, commenced the evaluation of this missile system.

THESE operations culminated a month ago when the MISSISSIPPI joined a large force of the Atlantic Fleet in an air-defense exercise and demonstrated the effectiveness of this new air defense weapon. Thus comes to fruition a guided-missile development commenced ten years ago.

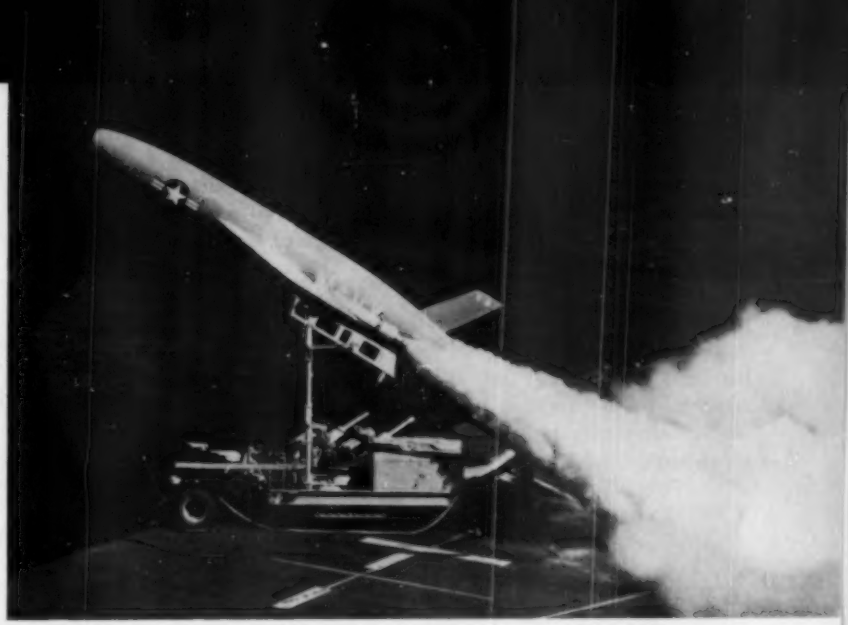
During the year immediately ahead, the heavy cruisers BOSTON and CANBERRA, having completed extensive modernization and conversion, will join the fleet as the first truly combatant guided-missile ships of this type.

The second successful guided missile is the Sparrow. It is the air-to-air type designed to be launched by one aircraft against another aircraft or a missile. In September 1952 the Navy's first jet fighter squadron equipped to fire these air-to-air missiles was commissioned. They have been participating in the test and evaluation of Sparrow continuously since that date, and the fact that the Sparrow is now in production and that several fighter squadrons are now being equipped to use it as a service weapon will attest to its success.



The Navy has a third successful guided missile called the Regulus. This is a large surface-to-surface missile designed to be launched from submarines and also from surface ships. It is powered by rockets and turbojet engines, is faster than conventional fighter bombers, and carries a devastating warhead to a target more than 400 miles away.

The development of this missile has reached the point where launching equipment is being installed in combatant ships and is already installed in several submarines.



The Navy surface-to-surface guided missile Regulus is fired from a portable launcher on the flight deck of the aircraft carrier HANCOCK during recent test operations.

An interesting feature in the development of this missile is the retractable landing gear installed in the test vehicles which permitted repeated test flights with the same missile—the record being fifteen successful flights with a single missile.

The heart of the development of these guided missiles has been the two large Navy research and development stations. One is the Naval Ordnance Test Station at Inyokern, Calif., birthplace of the Terrier and of the airborne rockets used in World War II.

This station also developed the deadly Mighty Mouse rocket which is now the primary air-to-air weapon of both the Air Force and the Navy. This is a small high-velocity rocket with a folding-fin feature which permits large numbers to be carried.

The second research and development station is the Naval Air Missile Development Center at Point Mugu, Calif., where the Sparrow and Regulus were developed.

The design and engineering genius behind these successful guided-missile systems has been certain scientific laboratories, aircraft manufacturers, and other industries with outstanding research and development divisions, such as the Applied Physics Laboratory at Johns Hopkins and the Convair Company for the Terrier; the Sperry Company for the Sparrow; and the Bendix Company, the Grumman Company, and Chance Vought Aircraft for others. They constitute a true example of fine civilian-Navy teamwork.

On March 5, 1954, Adm. Robert B. Carney, Chief of Naval Operations, addressed a letter to the Chiefs of all the Technical Bureaus of the Navy and the fleet commanders apprising them of the fact that our first missile systems would soon be reaching the fleet. He stressed the fact that overriding priority must be given to the task of integrating these missiles into our fleets and our air squadrons.

The initial versions of these missiles undoubtedly will possess known limitations when the fleet units first receive them, and the task of assimilating them into our combatant forces and assisting in their perfection will be an all-hands evolution of several years' duration.

Antisubmarine warfare is the Navy's toughest problem, and it is exclusively a Navy problem. It is one which confronts us with a grim reality equaled by no other problem. We do not have to guess about what we are up against. Russia has somewhere in the neighborhood of 375 submarines—twice as many as the United States has—and many times more than the Germans had at the start of World War II.

THERE is nothing glamorous about antisubmarine warfare, either in the research and development stage or in the actual operations at sea. In either case it represents hours, days, and weeks, of alert and exacting drudgery.

The most difficult problem is, of course, detection. After detection must come the effective delivery of a weapon against an unseen target which knows all the evasive tricks. Ten years ago the future of antisubmarine warfare was not bright, but since that time light has broken through, and effective countermeasures have been developed in detection equipment, weapons, and search tactics.

VASTLY improved sound-detection gear and magnetic detection gear have been developed. New and novel platforms for this equipment are available in improved blimps and helicopters with deadly new weapons to match. A new carrier antisubmarine warfare aircraft has been developed in the Grumman S2F—a twin-engine, long-endurance, electronics-laden airplane that combines rugged dependability with a load of the newest electronic detection devices and undersea weapons.

Another decisive step forward has been to assign to the antisubmarine forces several Essex-class carriers. Thus will be assured effective around-the-clock operations for our hunter-killer forces with capacity for fighter protection from within the force.

Of course, one of the most effective ways of countering hostile submarines is to destroy them at home in their building yards and refitting pens. This is a job for our fast attack carrier task forces which are capable of moving swiftly within aircraft range of enemy shores, pinpointing targets with atomic weapons, and retiring at high speed to a new launching point.

HOWEVER, without competent personnel to man and operate them, these extremely complex tools of war would be less than worthless. Our Navy is manned today with the finest and the best-trained men ever. Many are veterans with distinguished records in combat. They are skilled technicians in a wide variety of fields, principally in electronics, electricity, aviation, and steam and Diesel propulsion.

Many, many more are men in their first enlistment. These men have either just completed their training in these highly technical fields or are undergoing this training in the finest and most expensive schools in the history of the armed services.

This sounds as though our modern Navy is well fixed manpowerwise. The sad and serious fact of the matter is that just the reverse is rapidly becoming true. We are losing men in all ranks faster than we can reënlist, enlist, or train them.

The Naval Air Technical Training Command which I command trains 20,000 enlisted men a year at an average total cost of $3,500 a man. It takes well over a year to train a man in the formal schools, and it is two years before he is ready to take his place as a skilled technician at the radar sets of the ships and aircraft, in the engine and boiler rooms of ships, at the switchboards of our ship control rooms, at the weapons systems maintenance and testing equipment, and dozens of other key spots requiring a highly trained technician. Thus a trained bluejacket these days spends two years of his 4-year enlistment in training. How many of these highly trained first enlistees reënlist and thus

pass into the category called the backbone of the Navy—the hard core of career men dedicated to their country's service? Less than four per cent! There is not much arithmetic involved in figuring the tremendous cost of manning our Navy with competent personnel at this rate of turnover.

This serious problem was highlighted recently by the Womble Committee which was appointed by the Secretary of Defense to probe the causes and recommend remedial measures.

This committee concluded that the military service had lost much of its attractiveness as a career; that unless the trend of career personnel leaving the service could be reversed, most serious consequences to the national defense effort would result; that the responsibility for the present state of affairs rested not only with the military departments but with the Congress and many other governmental bureaus and agencies; and that corrective measures were entirely within our national capabilities but that they would require an all-hands effort, including the support of the American people, the Congress, and the Administration.

I do not want you to think that the Navy is not doing something about this situation. Certain administrative corrective measures can and are being taken, but legislation is urgently needed and above all the assistance of the American people in bolstering the pride of the man in his uniform and his service. He should be conspicuous only to the extent that his uniform indicates he is in the service of his country.

WHY should the newspaper headlines be twice as big and the emphasis twice as great in cases of the derelictions of a man in uniform?

Why should he be considered the legitimate victim of exorbitant rents and installment payments merely because he and his family have to live in a certain place at a certain time and his pay is steady?

Why should the few privileges which have existed for years to compensate for the low pay and extra expenses of a serviceman be successfully whittled away by certain greedy interests?

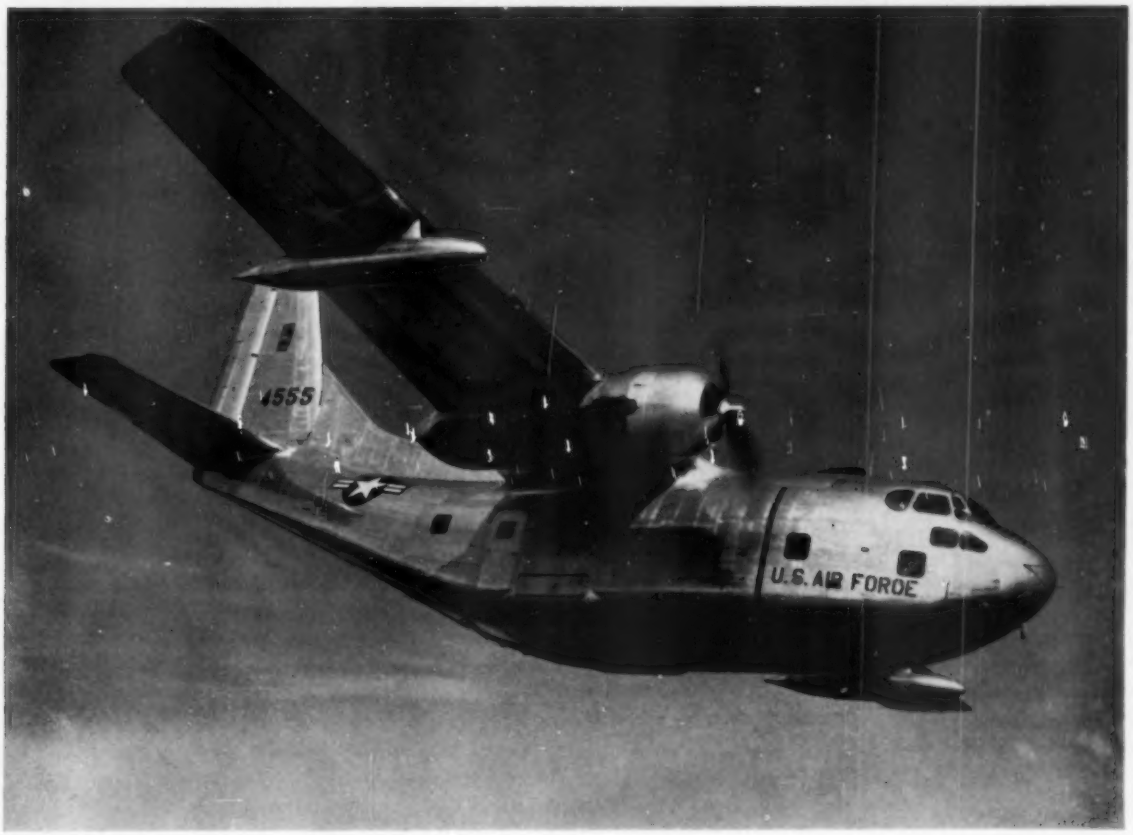
The Navy has instituted its own campaign to install pride in the service, point out the advantages of a service career, make a prospective reënlistee feel that the Navy needs and wants him. But it is difficult to compete just at this time with the GI Bill of Rights for service during the Korean war. Hundreds of thousands of enlistments from the onset of the Korean war are now beginning to expire.

IT is also difficult to compete with the attractive employment advertisements of private industry with which the serviceman whose enlistment is about to expire is confronted on every side.

Legislation is needed to increase the pay of the service and to increase it in such a way that a premium is put on longevity and career service. The personnel strength of the Navy should be adequate to insure that a fair shore-sea rotation program will permit a man to spend a reasonable period of his service with his family.

New Military Aircraft

Powered by a J-57 jet engine with afterburner, the Convair F-102A all-weather, day and night interceptor, above, has exceeded the speed of sound in level flight (Air force photo). Fairchild C-123 assault transports, like the one below, are being delivered to the 463rd Troop Carrier Wing at Ardmore, Okla. They can lift 60 troops or 24,000 pounds of equipment.



Armor for Atomic War

Lighter, faster, more mobile armored combat vehicles should be developed to enable our ground forces to exploit the tactical battlefield opportunities today's nuclear weapons will provide

Capt. John C. Burney, Jr.

"THE billowing mushroom-shaped cloud had hardly begun to settle when the flying tanks swept toward ground zero. The armored convertiplanes skimmed over the forests and swooped down upon the dazed enemy. Well protected by their turtlelike shells of laminated nylon, the tank crewmen crushed the foe with cannon, machine gun, and napalm.

"Never hesitating, task forces of these devastating flying tanks sliced through the last defenses. The battle was won and the exploitation well under way while the ominous white cloud still drifted overhead."

Without much imagination one can easily envisage such a battle report after reading current articles advocating "'copter cavalry." Unfortunately, however, helicopters and convertiplanes are in their infancy. A flying tank is not yet feasible.

BUT we do need appropriate armor for atomic warfare. The M48 and T43 tanks are too heavy, too slow across country, and too hungry. They will be misfits if we attempt to adapt them to the fast-moving scheme of global warfare. The machine gun forced the proud cavalryman to replace his horse with the tank. Certainly the adoption of nuclear and thermonuclear weapons will force changes in the cavalryman's present mount, the tank.

Before we consider the changes required to protect the tank from obsolescence, let's first consider the nature of warfare in which tactical atomic missiles are commonplace. How will their use affect the employment of armor in modern combat?

Captain Burney has served in various armored units and has completed the atomic weapons' course at the Command and General Staff College, Fort Leavenworth, Kans. At present, Captain Burney is stationed in the Pacific with the Eighth Army.

For maximum effectiveness, tactical atomic weapons should be used in close coördination with ground forces. Our combat units must remain far enough from ground zero to avoid friendly casualties but must reach the target area as soon as possible after the detonation. They must complete the destruction of the enemy before he can recover from the shock of our atomic blast. Only highly mobile forces can properly exploit the use of atomic weapons.

Our best defense against the enemy's nuclear weapons is to deny him profitable targets. Units must remain dispersed as much as possible, and vehicles must have excellent trafficability so that they can use all of their zones for maximum dispersion. The attacker must be capable of speedy concentration, providing only fleeting targets.

Assaulting forces cannot enjoy the use of assembly areas but should concentrate so close to the enemy that he dare not risk using atomic missiles for fear of inflicting casualties among his own troops. After an attack, units must disperse rapidly so that the enemy cannot effectively employ atomic weapons in his counterattack. Dispersion and speed are our best protection against the atom.

This requirement for swift concentration and dispersion places a premium on mobility. He who possesses the equipment with the greatest mobility will be a heavy favorite in atomic warfare.

A highly mobile tank would be an ideal partner for the atom. Armor's firepower and shock action integrated with the devastating effects of nuclear weapons make its presence essential in a future war.

In addition, the tank is relatively invulnerable to nuclear attack. Blast is the principal atomic effect capable of defeating armor, and the very high pressures required and the short radii of these pressures make the tank an unprofitable target. If the enemy detonates his weapons low enough to achieve effective pressures, he sacrifices a more important effect—heat.

Even a thin sheet of armor plate is an excellent shield against heat, the primary casualty-producing effect of atomic weapons used against troops in

the field. The tank crewman is the safest man on the atomic battlefield. He can advance close to the bursts of his own supporting weapons. He might even advance under the effects of low-yield air bursts as is done today under overhead artillery fire. The tank's speed can carry crewmen quickly through areas contaminated by surface bursts. The atomic bomb has increased immeasureably the value of armor.

Unfortunately, our present family of tanks, the M41, M46, M47, M48, and T43, are poorly suited for the nuclear age. Our tanks are too immobile and too slow across country. Cross-country mobility and speed are essential to vehicles which must effect the rapid concentrations and dispersions of atomic warfare.

WE are going the wrong way on the right road. Each of our tanks is bigger and heavier than its predecessor. The price that we pay for this weight is measured in miles per hour and restricted cross-country mobility.

Armor's trafficability is poor. Korea is a glaring example of our tanks' limitations. We must have lower ground pressures—eleven pounds per square inch is too restrictive. Our tanks must be capable of climbing steeper slopes under more adverse conditions. In a war of movement we will not have time to winch tanks into firing positions as was done in Korea.

If you have any doubts as to the lack of mobility, cross-country speed, and trafficability of our tanks, "ask the man who owns one"—ask a tank company commander who has employed tanks under varied conditions of terrain and weather.

Our tanks do not have sufficient ranges for highly mobile combat. Do you realize that the range of the M48 is only 70 miles? The range of the Russian T34 is approximately 180 miles. During World War II, a decade ago, Russians and Germans conducted exploitations 200 to 400 miles in depth.

The atomic bomb will further open up warfare. The need for dispersion will create gaps, and forces will be deployed on wider frontages and in greater depth. Small, highly mobile task forces will have opportunities to strike far into the enemy's weak rear areas. They must be able to traverse great distances swiftly.

"A highly mobile tank would be an ideal partner for the atom. Armor's firepower and shock action integrated with the devastating effects of nuclear weapons make its presence essential in a future war. In addition, the tank is relatively invulnerable to atomic attack."

In a war of movement, deeply striking task forces cannot be concerned with supply lines. At times, the airplane will be the only carrier capable of the logistical support of our tanks. But the airplane is seriously limited in its cargo-carrying capacity. Two hundred and twenty C-119 Flying Boxcars (our standard troop-carrier airplane) are required to deliver by parachute the gasoline required to move an armored division one hundred miles. Tankers have found that their M48's consume five to seven gallons a mile in cross-country operations. The logistical support of armor has become a nightmare.

We have so far considered only tactical or battlefield mobility. What about strategic mobility? The next war will certainly be a global one. The key to strategic mobility is transport aircraft. We will soon have troop-carrier airplanes that will carry as much as fifty tons. The new T43 tank weighs approximately sixty tons.

We can build airplanes to carry our tanks, but one expensive aircraft will be required for each tank. Would you use that airplane to carry one tank or 400 combat-equipped infantrymen? Our tanks must be lighter to facilitate their air transport; we must add strategic mobility to the tank's tactical mobility.

Our airborne divisions suffer most from the tank's excessive weight. The primary antitank defense in the airborne division is provided by the 138 M48 tanks. However, these tanks are too heavy to be carried in the airborne section of the division, so that just when the paratrooper is especially vulnerable to attacks by enemy armor, when he needs every antitank weapon available, he is deprived of his best antitank weapon.

But how can we make the tank light enough to permit air transport? How can we give it the needed speed, trafficability, and mobility? We can do all this simply by decreasing the tank's weight, primarily by decreasing the size of the tank and the thickness of its armor.

We should end the senseless race of armor thickness versus antitank weapons. As we provide thicker and heavier armor, lighter and more powerful antitank weapons are developed.

It is impossible to make our tanks impenetrable, so we should provide little more than the armor required to protect crewmen from the greatest killers of past battles—shell fragments and small-arms fire—and from the most effective killer of future battles—burns from atomic blasts.

Only two to three inches of homogeneous steel is necessary for the most vulnerable parts of the tank; the addition of the many more inches required for protection against weapons designed to penetrate thick armor plate entails dangerous sacrifices in speed and mobility.

TESTS would probably prove that by reducing the thickness of our armor we could actually increase our protection against antitank weapons. We certainly can't achieve invulnerability to antitank guns by adding more and more armor, but we can make our tanks harder to hit by making them smaller and faster.

The most common antitank weapons in the infantry are recoilless guns and rocket launchers. Projectiles from these weapons have low muzzle velocities; they take relatively long times to reach their targets. The best method of escaping their deadly shaped charges is by decreasing the target area and increasing speed and mobility—not by increasing armor.

Thinner armor is sometimes advantageous. Solid, high-velocity rounds that penetrate both sides of a tank do less damage than those which penetrate one side and ricochet around inside the hull.

Some emphasize the psychological effects of heavy armor protection. Our soldiers are taught the capabilities of antitank weapons and have seen the gaping holes punched in tank hulls and turrets during the Korean fighting. The best way to instill confidence in our tank crewmen is to give them the ability to avoid antitank projectiles.

We should investigate every means possible to decrease the thickness of armor. The use of stronger alloys or even nonmetals (such as laminated nylon) might prove rewarding. Design studies might produce hull and turret shapes that would make increased use of the slant thickness of armor plate.

We should continually reëvaluate the protection required by each of the tank's sections and strive to place each vulnerable component where it can be most efficiently protected.

WE might further decrease the weights of our tanks by providing lighter guns of smaller caliber. The use of smaller projectiles would lessen the weights of combat-loaded tanks and facilitate logistical support. Smaller, lighter ammunition is easier to handle inside a crowded turret and permits a more rapid rate of fire—a most important consideration in tank-versus-tank combat.

We should certainly not sacrifice the effectiveness of our armament to obtain lighter guns and ammunition. But we should investigate every potential means of producing smaller cannon and projectiles with satisfactory accuracy and armor penetration.

The tank should be as simple as practicable. As the number of gadgets, parts, and engine components increases, so do size, weight, and likelihood of mechanical failure. As the materials and cost of each tank increase, the number of tanks that we can afford decreases. The Russian T34 had few refinements, but the introduction of this tank turned the tide of the Wehrmacht's advance on Moscow during World War II.

We could decrease the weight of fuel carried and the volume of fuel storage if we could increase the efficiency of our power units. Perhaps the use of Diesel engines would help solve our problems. We use atomic power for our latest submarines. Could tanks be driven by atomic energy?

Reducing the weight of any one of the tank's components will result in the lightening of other components. For example, let's remove a ton or two of armor plate. Less power will be required to drive the lighter tank, and a smaller engine with fewer parts can be used.

This engine will consume less fuel, so fuel storage space can be reduced. With smaller engine and fuel tanks we can decrease the size of our tank, and less armor will be required to cover the reduced volume. This decrease in armor starts another cycle, and the tank's weight can be further reduced.

The cycle has been running in the opposite direction since World War II, and, like a snowball rolling downhill, the tank has been collecting more and more weight. We must reverse this trend and start the cycle toward a lighter tank with greater cross-country speed, range, and mobility.

The adoption of a lighter, more mobile tank to exploit the firepower of our new missiles and atomic weapons would result in more versatile and effective use of armor. Surprise could be achieved more easily with a lighter, smaller, quieter vehicle. Relaxing supply and maintenance restraints will permit bolder, more flexible use of armor.

It is mandatory that we be fully prepared to meet changes forced by atomic weapons. General Bolte, at the sixty-fifth annual convention of the Armor Association, stated: "I want to assure you that the concept of mobile warfare is acquiring added importance as the effects of new weapons and their influence upon tactics and strategy are studied."

The famous mushroom cloud rises above the Nevada Proving Grounds during recent atomic tests (Army photo).

WE must act now to provide proper equipment for highly mobile tactics. We may not have time later.

We must give our tank the qualities to make it a worthy partner of the atom. We must give it speed, range, and trafficability. We must free it from its logistical shackles. We must lighten the tank so that it can have the strategic mobility it requires for global warfare. We must devise a new tank to meet changed conditions.

The champion of a decade ago won its laurels by close coöperation with its teammates. But now more powerful teammates have arisen—and they'll not be satisfied with a has-been.

EDITOR'S NOTE.—The statements and opinions expressed in this article are those of the author only and are not necessarily those of the American Ordnance Association.

The Army's Flying Truck

In Korea the helicopter proved its ability as a transport vehicle by supplying an entire division for 6 days, moving a total of more than 2,350,000 pounds of food and equipment on schedule

Harry A. Jacobs

ON December 7, 1954, the world's first airport built exclusively for military helicopters was dedicated at Fort Eustis, Va., center for Army transportation training and research and development. Construction of a permanent heliport is a sign of the increasing importance of the helicopter in twentieth-century military transportation.

The new facility was named "Felker Heliport" in honor of Warrant Officer Alfred C. Felker, an Army helicopter pilot killed during a duty flight on February 10, 1953. Participation at the dedication ceremonies by Joseph P. Adams, Civil Aëronautics Board; Earl D. Johnson, Air Transport Association president; Igor Sikorsky, pioneer helicopter developer; and top Department of Defense officials underscored the significance of the occasion.

THE heliport's physical layout differs from conventional airfields. Instead of the familiar rectangle, crisscrossed by diagonal runways, it consists of a large circle, surrounded by a number of circlets. The main circle looks like a giant Ferris wheel. The rim is composed of a belt taxiway, while the spokes are represented by two runways crossing at the center.

Each macadamized runway is 600 feet long, dividing the field into 4 equal sections. The eight smaller circles extending outward from the taxiway are landing pads. Helicopters ascend from and descend on the pads, except when heavy loads or adverse atmospheric conditions require the use of runways for take-off and landing runs.

Mr. Jacobs is with the staff of the Office, Chief of Transportation, Department of the Army, Washington, D. C.

In addition to the landing field and pads, the million-dollar installation includes a huge hangar, an operations and administration building, a spacious equipment and spare-parts warehouse, and a helicopter "parking lot."

The 230 by 160-foot hangar can accommodate the largest cargo-type 'copters available today and still has enough room for five separate maintenance shops. A modern glass-enclosed control tower is situated on top of the operations and administration building. Located across the front of these structures and the warehouse is a 750-foot-long, asphalt aircraft parking area.

The establishment of Felker Heliport is not significant merely because it is the first military facility of this type. To understand the real meaning behind this event it is necessary to turn the clock back to the days of the Korean conflict, for then and there the helicopter made military transportation history which foreshadowed the existence of a heliport and other Army aviation developments.

The Army's interest in the helicopter, of course, predates Korea. It may be recalled that the first models of practical rotor-winged aircraft evoked widespread curiosity just before the outbreak of World War II. However, the "eggbeater"—as it was often nicknamed—soon faded into the background when wartime requirements demanded concentration of research and production on more urgently needed weapons and equipment.

It was only after World War II that the Army was able to pay closer attention to the 'copter. In the Korean conflict—but six years after the surrender of Japan—Army helicopters were a common sight over the battle lines.

The helicopter was able to play an unexpected rôle in Korea because the Army recognized its potential when it was still an object of amusement as a "stunt vehicle" at county fairs.

AS a result of fragmentary 'copter experience during World War II and on the basis of the limited testing possible with the few craft available after the war, the Army came to the conclusion that a rotor-winged troop and cargo transporter could become a key factor in battlefield mobility.

Even at that time the Army was not primarily interested in the helicopter as a utility vehicle, air ambulance, or carrier of food and ammunition to cut-off or isolated individuals or small groups. Rather it thought of these awkward appearing "eggbeaters" and "whirlybirds" as flying trucks and "air buses."

In 1949 the Army helicopter began to come into its own. At that time the Army spelled out its need for a large, rugged 'copter capable of carrying squads of armed soldiers and sizable quantities of military cargo. Procure-

Above, the engine of a Sikorsky H-19 gets a regular maintenance check. Below, another H-19 delivers rations to a combat team during Korean fighting (Army photo).

ment was initiated, and in November 1950 the first army transportation helicopter company was activated.

FROM then on, military rotor-wing aviation grew by leaps and bounds, both as a transportation medium and in quantity. In December 1951 the Army Aviation School's first helicopter pilot course, which counted the then little known Warrant Officer Felker among its members, was graduated.

Maj. Gen. Frank A. Heileman, Army Chief of Transportation, 1948-1953, addressing the class, said that the helicopter "represents a greater relative advance in mobility of the Army than did the introduction of the motor vehicle."

When the general uttered these prophetic words, Army cargo helicopters had not yet been employed in Korea, and their value in combat situations was by no means assured.

But he had a good idea of what the helicopter could do. He had observed the first Army "chopper" unit, designated the 6th Transportation Helicopter Company, participating in Exercise Southern Pines—a maneuver held in the Carolinas in August 1951. After barely six months of training and equipped with only the light Hiller H-23, the unit gave an indication of what it could accomplish with more experience and larger helicopters.

The 6th Helicopter Company was given further opportunities to demon-

The Piasecki twin-engine YH-16, below, with its great capacity, can lift up to 5 tons of equipment or 46 men (Signal Corps photo).

strate its capabilities. In January 1952, flying Bell H-13's, it accomplished all assigned missions in spite of the freezing temperatures prevailing during Exercise Snowstorm at Camp Drum, N. Y.

In the spring of 1952 the company received its first specially designed cargo 'copter, the Sikorsky H-19. Using the new craft in conjunction with H-13's it flew 650 hours, carrying supplies and personnel during Exercise Longhorn in March and April 1952.

By then, Army aviation and transportation experts had seen enough: the 6th was ordered to Korea in November 1952. The opportunity which helicopter supporters within the Army had been waiting for was at hand. The "chopper" would finally get the chance to prove its value in actual combat.

WHAT was the helicopter's performance in Korea? Initially the 'copter had to strive for recognition. Seesaw fighting had been going on for several months, and the commanders in the field were in no mood to "experiment." During the first few weeks, the whirlybirds were mostly used for the transport of wounded and small emergency missions.

However, the 'copter was soon recognized as being something useful to have around. Many a wounded man is alive today because a helicopter was available to pick him up and get him to the medics while there was still time.

But while its reputation in medical evacuation was assured, many fighting men, from privates to top commanders, were skeptical in their appraisal of the 'copter's value in large-scale logistic support to combat units.

However, in March 1953 the 6th Helicopter Company was suddenly called upon to haul badly needed supplies to 3rd Infantry Division elements which had been isolated by flash floods. Flying 19 H-19's, within a span of 90 minutes the pilots hauled 34,000 pounds of cargo, consisting of Classes I (rations), III (fuels and lubricants), and V (ammunition).

THREE days later the 6th was sent on another emergency mission. This time it was to evacuate groups of casualties from "Old Baldy." Again the 'copters came through. The net effect of these two performances was to focus attention on expanded future missions.

Eighth Army staff officers now were eager to find out just how well helicopters could perform in daily supply operations. Accordingly, Operation Skyhook was ordered.

For the first time in world military history the combat elements of a division were to be totally supported by helicopter airlift! Between May 22 and 24, 1953, the three regiments of the 25th Infantry Division deployed along the main line of resistance were to depend upon helicopters for all their food, gasoline, ammunition, and other supplies.

The result: During the 3-day operational period the 6th Helicopter Company delivered over 600,000 pounds in 843 flights.

Better that ninety-eight per cent of the total programmed cargo reached its destination! Eighth Army headquarters was pleased with the success of Operation Skyhook and ordered another similar exercise to test helicopter capability over an even longer period.

Again the 25th Infantry Division was to look exclusively to the 6th Helicopter Company for its transport requirements, but this time for a 6-day period.

The unit did it again. Transporting over 2,350,000 pounds in this operation —designated Skyhook I—the eggbeaters again met all basic supply needs and fullfilled programmed cargo requirements 100 per cent. By increasing the cargo carried externally in a sling, they were even able to enlarge the average payload.

THE two Skyhook operations proved the helicopter's capability of providing supply support for larger units. Yet it may be pointed out that, in the two cases cited, the units previously had been satisfactorily supported by highway transport.

But how would the helicopter perform in an entirely new and unplanned situation? The last day of June 1953 brought the answer to this question.

On that day the Communists launched an offensive during which a realignment of our main line of resistance took

Air view of the world's first military heliport now in full-scale operation at Fort Eustis, Va. (Army photo).

place, and the 5th Regimental Combat Team was cut off from the existing supply line. Dug in on what became officially known as Hill 1065, it was isolated from the road on which trucks had been hauling its supplies.

In similar situations in the past, "chogibearers"—members of the Korean Service Corps—would have been called on to plug the gap until normal trucking operations could be resumed. In this instance, however, topography, distance, and the large tonnage of needed supplies precluded dependence upon Korean bearers.

The situation demanded a vehicle which combined the agility of a pack mule with the carrying capacity of a truck. Between June 30th and August 2nd an average of six H-19's continuously lifted supplies to the combat team. For thirty-two days the whirlybirds provided the sole access to and from Hill 1065. In 550 flight hours, 787,000 pounds of cargo, including food, ammunition, equipment, and clothing were delivered. In addition, twenty casualties and twenty-four other soldiers were flown from the ridge.

THIS, in brief, has been a recapitulation of the helicopter record in Korea. Recognition followed as news of the Skyhook operations and Hill 1065 spread, and a change in the combat man's concept of the whirlybird took place. Henceforth the 'copter no longer was merely an angel of mercy or a new-fangled vehicle on inspection tours.

The new attitude is best expressed in a letter sent on October 1, 1953, by Gen. Maxwell D. Taylor, Eighth Army Commander, to Maj. Gen. Paul F. Yount, Chief of Transportation, Department of the Army. It stated in part:

"The Transportation Helicopter Company, newest addition to the transportation family of the Eighth Army, has already proved itself a most valuable member of this military team. The 6th and 13th Transportation Helicopter Companies have, during the period of their assignment to Eighth Army, been utilized in many ways. They have evacuated wounded, moved battle-equipped infantry units and emergency supplies to areas virtually inaccessible by other means of transportation. . .

"You are familiar with the experimental operations 'Skyhook' and 'Skyhook I.' These operations have left little doubt as to the capability of the cargo helicopter to fly units and supplies to points beyond the means of other methods of transportation. Subsequent combat operations have tended to substantiate this belief.

"The cargo helicopter, employed in mass, can extend the tactical mobility of the Army far beyond its normal capability. I hope that the United States Army will make ample provisions for the full exploitation of the helicopter in the future."

The performance of the helicopter in Korea demonstrated the capability of organic Army aviation to provide the combat forces with the degree of mobility required in present-day and future warfare.

The Army helicopter is here to stay, and it will play a vital rôle in the coming years, for the hope expressed in the words of General Taylor's letter of October 1, 1953, is being fulfilled.

Recently, an Army aviation build-up to twelve transportation helicopter battalions was ordered. Two battalions are already in existence, one in the Far East, the other in Europe. Other units are in the process of being established.

Progress in attaining the 12-battalion goal will necessarily be slow because of the large number of pilots needed and the relatively few late-model helicopters immediately available.

To overcome the manpower problem the facilities of the Army Aviation School, now located at Camp Rucker, Ala., are being fully utilized, and other training activities are being established. In this connection, the new heliport at Fort Eustis will play an important part.

In addition, steps are being taken to create an attractive career program for pilots and maintenance personnel. It is of interest to note that Army helicopter pilots are already making aviation history. During the past summer one of their number, Warrant Officer Billy Wester, established new world's speed and altitude records for helicopters.

To enable its helicopter units to carry larger payloads than has been possible with equipment available in the past, the Army is developing a new "family" of 'copters. Members of this group are the Piasecki H-21 and Sikorsky H-34 capable of carrying 1½ tons or 12 field-equipped soldiers; the Sikorsky H-37, with capacity for 3 tons of cargo or 24 soldiers; and the Piasecki YH-16, rated at 5 tons or 46 soldiers.

THESE craft will provide greater flexibility to air transportation. The Army will be able to match the equipment with the specific requirements of the mission.

Army aviation planners now are looking beyond getting bigger and better 'copters. They are interested in the development of the convertiplane, an air carrier which seeks to combine the best characteristics of both the helicopter and fixed-wing craft.

At this time two convertiplane models are undergoing military tests. The McDonnell XV-1 operates on a single power plant. For take-off and landings it depends on a rotor system, while for horizontal flight it is motivated by a pusher-type propeller.

The Bell XV-3 is equipped with two rotor-propellers, one mounted on the tip of each wing. During vertical flight they act like helicopter rotors, but once sufficient altitude and speed are gained the blade assembly is tilted forward and then acts as a standard propeller.

SUPPORT of civilian industry in convertiplane research represents the "forward" look in Army aviation. If the convertiplane can improve upon helicopter speed and range it may add further flexibility to Army air transportation, particularly in cases where speed and distance factors predominate.

EDITOR'S NOTE.—In an article, "The Helicopter in Combat," published in the March-April 1954 issue of ORDNANCE, Joseph Bonanno wrote: "The helicopter appears to be ideally suited for antisubmarine and antimine work. It has several advantages over conventional aircraft in that it need not circle over the target . . . and it provides a better platform for bombing."

Guided Missile Maintenance

The new weapons with their complicated propulsion, launching, and guidance systems are creating difficult but not unique problems in keeping them always ready for effective use at a moment's notice

C. C. Martin

AFTER passing through the glamorous stages of development and successful prototype tests, guided missiles are now facing the more mundane problem of maintenance in the field. Although there is nothing fundamentally different about guided-missile maintenance, it does have some new and sometimes acute problems requiring particularly diligent efforts to solve.

Guided missiles, like all Army equipment, must be reliable and ready for use at any time. Although these goals are never completely met they have been quite well achieved in conventional weapons. However, conventional weapons are not able to meet the stringent tactical requirements that brought about the development of guided missiles.

TO meet these new military characteristics, guided-missile systems are necessarily more complex than conventional weapons systems, and, in particular, the missile is far more complicated than ordinary artillery or small-arms projectiles.

Add to this the fact that most existing missiles were engineered and produced on an expedited basis dictated by world developments and you have a situation full of challenge for maintenance men.

Guided-missile matériel can be classified conveniently as the missile itself, the ground fire-control equipment, the launching equipment, and the supporting maintenance equipment. Missile fire-control equipment is superior in accuracy and performance to even the most modern artillery fire-control electronic gear, but it is not substantially different in construction or maintenance requirements.

Although requiring particular care in adjustment and operation, it presents few problems not already associated with the use of other up-to-date radar and computer equipment.

Missile launching and handling equipment is not greatly different from similar material used in the field army except where opportunities for lightweight construction have been exploited.

True, additional development must be carried out before missiles can be used in the field with the same facility as a 120-mm. antiaircraft gun or a 155-mm. artillery piece. However, maintenance problems now associated with missile launching and handling equipment are usually no more acute than those encountered with automotive vehicles and gun carriages. Most of the problems are now being eliminated by continued tests, and they would not have existed in the first place had "crash" programs not required production before completion of customary engineer and user tests.

The really new aspects of guided-missile maintenance are associated with the missile round and some of its specialized test equipment, and the following discussion will concentrate on these.

As noted above, missiles must be ready for tactical use at any time, and because of the increased number and complexity of their components they are far more likely to become inoperative at any time. Furthermore, it is not practical for using personnel to make actual operational tests of many items, such as rocket power plants.

Those items that can be checked cannot be subjected to actual flight conditions, for the environment of sitting quietly on the launcher is far different for the missile than its supersonic flight at high altitude, with accompanying violent maneuvers and rugged vibration.

If a person had to be ready, at a moment's notice, to drive his car five hundred miles but had to let it sit in the garage for a few months or years without doing anything to it except periodically turning the radio on and the starter over, he would be in approximately the same situation as a guided-missile commander.

Despite the complications presented above, the problems are being solved. First of all, those components that can-

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not be tested must be designed to be particularly rugged and reliable. Secondly, the missile must have provisions for testing its most critical components at periodic intervals. Thirdly, simple, reliable test equipment, of the "go, no-go" type where possible, must be provided. It is necessary that particular attention be given to continued maintenance and careful adjustment of test equipment so that it will actually test the missiles and not vice versa.

Finally, and perhaps most important, all operating and maintenance personnel must be thoroughly indoctrinated with the idea that no repair is satisfactory unless the part has been completely tested with the specified test equipment.

Nothing could degrade the reliability and performance of a missile system more than "tinkeritis," and the worst part is that the sad results might not be known until an unsuccessful missile firing in combat.

IN addition to checks made at tactical locations, periodic overhaul of missiles must be scheduled. A slightly different philosophy is in order here, since missile rehabilitation is to some extent a form of preventive maintenance; components that cannot be checked when the missile is on the launcher can be tested during the overhaul.

One might say that, in the interests of reliability, missiles are overhauled and simultaneously given the more elaborate field-maintenance checks a considerable time before they become inoperative instead of shortly before.

Clearly, then, it is important to test missiles frequently enough to ensure their combat readiness, but it is also possible to test them unnecessarily. When in storage they should be left there undisturbed except for periodic checks at considerable intervals dictated by the life of components made of rubber and similar materials. As one experienced and knowing authority in the field has said, "It is like storing eggs—once you have put them in a box, you don't take them out and look at them every day to be sure that none of them are broken."

Considering the present state of the art, a thorough check before shipping a missile from a depot is probably in order, but eventually even this should be unnecessary, just as it is with conventional ammunition.

It is worth pointing out that the operating life of many missile components is only a small fraction of that of their test equipment; hence, tests should be made when required, and only then—not whenever the troops have no other pressing occupation.

It must be recognized that guided missiles are the product of a new and rapidly changing art. Like any new technology, growth of knowledge proceeds at a phenomenal rate. Continued research and development produces performance and reliability improvements so important that the defense effort absolutely cannot afford any postponement of their incorporation in field equipment.

This means troublesome modifications, but continued training of personnel and the development of flexible organizations and outlooks can lessen the pain. Incidentally, during any possible future combat this flexibility would be a great asset in fighting the constantly changing battle of countermeasures and counter-countermeasures.

Certainly there is nothing in the construction of well-designed guided missiles that is beyond the maintenance capability of well-trained units. However, certain materials and design features are different from any of those previously in field use. Most missile liquid propellants, particularly those used as oxidizers, have unpleasant characteristics.

For example, red fuming nitric acid is highly corrosive and must be handled with care. Even missile powerplant materials selected for their resistance to this acid must be examined carefully during overhaul to ensure their suitability for continued use.

Guided-missile control surfaces require the application of high power at a very fast response time in order to achieve adequate supersonic stability and control. Also, a large amount of power must be consumed in pumping liquid propellants into a combustion chamber.

The best design solution to these requirements frequently employs the use of compressed air at pressures running into thousands of pounds per square inch. The tremendous amount of energy stored in a relatively small missile tank is difficult to visualize.

Without training, a maintenance man who would treat a bomb with every respect might handle the missile air system in a manner so casual as to be dangerous. Furthermore, techniques suitable to handling pressurized air in a tire are by no means suitable for the much higher air pressures used with missiles and associated test equipment.

WHEN a dented automobile fender or other sheet metal part is returned to an ordnance shop for repair it can be competently hammered or welded back into shape. If a small mechanical part is missing a new one can be manufactured in the machine shop. These practices are unfortunately not suitable for components of a guided missile. Most structural parts are made of carefully selected, high-strength, heat-treated alloys that can be formed only under controlled conditions.

Furthermore, requirements of light weight demand the most careful structural design; therefore, any defective missile part should be rejected in the interest of reliability. Even where depots are equipped to undertake such repairs, the cost of personnel training and special equipment should be weighed against the cost of a new part. Components can, of course, be repaired by replacing defective parts and testing the new assembly as required.

In other missile applications, special materials are used for O rings, seals, gaskets, and associated parts. Many of these components are similar in appearance to others not compatible with the type of hydraulic oil, propellant, or material used in the missile. Also, they may require special handling and installation techniques.

Repair of electronic components in missiles must be done with particular care. Good design practice provides that many subassemblies be plug-in units. If these units have defective parts whose

replacement requires soldering, they should be repaired only under the most carefully controlled situations, usually only at depots. Not only must the personnel doing the soldering be experienced and thoroughly trained, but an exceptionally effective quality control must be used.

IT should be noted that the situation regarding missile parts is quite different from that pertaining to ground units. The missile is subjected to vibrations, shocks, and accelerations during flight, and only the best workmanship will survive often enough to achieve the desired high reliability.

Subject to the limitations noted above, maintenance personnel experienced in automotive or fire-control work can readily be trained to handle missile mechanical or electronic repairs respectively. It should be recognized that missiles use many aircraft design practices to achieve the high strength and light weight necessary for efficient design.

These practices and the associated hardware are not more complicated or more difficult to work with than standard automotive components; they are just different. Once this fact is recognized, some additional training provides the required competence for shop mechanics and inspectors.

Ordinary post or field ordnance facilities with some modifications are suitable for third-echelon work in the field-maintenance category. Use of high-pressure air requires additional equipment and simple blast shelters. For detailed disassembly of hydraulic components, a reasonably dust-free work space should be available. Overhaul of missiles requires a considerable amount of floor space to attain production-line economies, but no special facilities other than the high-pressure air and "clean" rooms are required.

A FEW special tools and some commonly used in aircraft but not in ordnance shops are needed. Despite these minor additions, a missile overhaul shop would not differ greatly from a combined automotive and fire-control overhaul operation.

As discussed above, the requirements of thorough testing dictate the characteristics of missile maintenance equipment. Indeed, most specialized units found in missile repair shops are for testing and not for the actual repair operations which can be done primarily with common tools.

It is important to recognize the fact that any field-maintenance shop or unit requires some specialized test equipment to perform its mission. Whether or not it repairs components, it needs the test equipment to determine which assemblies are good and which are bad.

A question might be asked, "Why special test equipment at all?" The answer lies in one of the many compromises that always face designers and maintenance planners.

For many complex missile tests, only the most skilled personnel could make consistently accurate check-outs of components, and then at a relatively slow rate. The specialized equipment permits rapid and efficient testing by personnel of moderate skills, and these savings of time and increased reliability more than pay for the test gear.

Very few supply problems associated with missiles are unique to them. Like all weapons systems containing items supplied by several technical services and containing parts in many letter groups, adequate supply is a continuing challenge. Because of the possible catastrophic consequences of a deadlined battery, particularly in antiaircraft installations, the present expedited requisitioning procedures are well justified.

Testing a Nike.

Initial spare-parts stockage of the first guided-missile systems to reach the field will be supplemented as experience is gained. One interesting new problem concerns placing the missile itself in either the general-supply or ammunition-supply category. A missile is expendable just like any other round of ammunition and is issued to using troops by conventional ammunition methods.

On the other hand, unlike most other rounds of ammunition, a missile requires constant maintenance, including replacement of parts at the organizational, field, and depot maintenance levels. The type of parts required for this activity cannot conveniently be supplied through the customary ammunition channels.

Also, the conventional ammunition supply installation or organization is not equipped with the equipment, skills, or facilities to effect missile maintenance. This situation is being solved, but it does require a more or less flexible outlook toward established supply procedures.

TO conclude, it may be said that guided-missile maintenance represents a stimulating but not impossible challenge to the ordnance-maintenance team. New techniques and skills must be learned by maintenance personnel and some accepted practices must be discarded in so far as missiles are concerned.

Experience of tactical units and maintenance installations must be continually and carefully reviewed to determine the optimum testing and overhaul schedule in order to guarantee the resultant high reliability and constant readiness.

A few years from now, when all these problems have been solved, the guided missile will be just another maintenance problem going through the shop, even though it is among the most strikingly effective of Ordnance weapons used in our Nation's defense.

How To Prevent War

It may be possible to postpone a general conflict indefinitely if our weapons of defense and retaliation are powerful enough to make the risk too great for a potential aggressor to take

H. S. Vance

ONE of the phenomena of the present period is the enormous growth in the ranks of self-styled military experts in our country. Every columnist, almost every writer for newspapers or periodicals, even some men of the cloth, and of course, every last politician, either in or out of office, has very definite ideas about what is wrong with the world, how to prevent another global war, and how to win such a war if it is thrust upon us.

Perhaps this very wealth of opinion is a principal cause of the confusion which exists in the minds of so many of us today.

I am no military expert yet, paradoxically, I propose to give you a simple formula by which I believe we can remove the fear, or at least any real basis of fear, that another general war will plague us in the foreseeable future.

THOSE who have been engaged in the manufacturing segment of industry are acutely aware of the evolution or, perhaps, the revolution, which has occurred in production methods during the last generation. Machine power has been substituted for manpower. Even machine "thinking" has been substituted for human thinking, to such an extent that a new word has been coined to describe the process—"automation."

A similar evolution, again of revolutionary proportions, has taken place in the art of waging war—an evolution of the same kind as that of industry, in that weapons and instruments are replacing manpower as the all-important factor in military might.

Mr. Vance is chairman of the Executive Committee, Studebaker-Packard Corporation, South Bend, Ind. This article is taken from an address given by Mr. Vance at the Annual Dinner of the Cincinnati Post of the American Ordnance Association held recently in Cincinnati, Ohio.

We persist in using employment as a yardstick for measuring the size and importance of an industrial enterprise, and so it is to be expected that we would continue to do the same thing in measuring military strength.

Recently one of our top military experts predicted that the armed forces would require more manpower than heretofore as a result of the development of atomic weapons. But the fact of the matter is that, now and in the future, it is the amount and the quality of the *equipment* we furnish our armed forces which will determine their striking power, and not, as in the past, the size of these forces in terms of men.

When the British Expeditionary Force was compelled to evacuate the Continent in 1940, the personnel of a seasoned army was saved, but all its equipment—tanks, guns, even small arms—was lost, with the result that that repatriated army was helpless against a threatened invasion across the Channel which, happily, did not materialize. I cite this as an example of the importance of the *amount* of the adequacy of military equipment.

When the French Army faced the Germans from the outbreak of the war in September 1939 until June 1940, the French had more guns and more tanks than did the Germans, but the French equipment was largely of World War I vintage—a fact which contributed largely to the fall of France. I cite this as an example of the importance of *quality* of equipment as distinguished from adequacy or amount thereof.

If my premise is correct—that amount and quality of military equipment are of paramount importance in modern warfare—it follows as a matter of course that they must be of the same importance in a defense program.

Our defense program has a twofold objective. Part of this objective is, of course, the successful waging of war if it must come. But the more important part is the prevention of war by showing potential enemies, in a clear and unmistakable manner, what the outcome of a war would be.

THE recently deceased dictator of a powerful nation, over whose policies we have been greatly concerned, is reported to have said that he had made a careful study of the history of all preceding dictators from Alexander the Great down to our modern Hitler and Mussolini, in order that he might discover and avoid their fateful mistakes,

because he knew that all of them, without exception, had wound up in disaster.

His conclusion was that dictators should avoid wars, at all cost, if they involved a substantial risk of losing everything which had been previously gained. This is a sound philosophy which I hope and believe will continue to guide the successors of the dictator in question.

Therefore, my thesis is that we can prevent war indefinitely if our defense program is of such a nature as to keep in war itself such a large element of risk—for our opponent, of course—that the probability of losing everything previously gained simply makes war a bad gamble.

LET us put this idea to the test in a specific situation. Some time ago I was one of a small group which studied the problem of defense against aërial attack on the continental United States. Besides our own findings and those of military advisers, we had available to us the data and conclusions contained in similar studies previously made.

"Our defense program has a twofold objective. Part of this objective is, of course, the successful waging of war if it must come. But the more important part is the prevention of war by showing potential enemies . . . what the outcome of a war would be."

It was my personal conclusion that there is no way of affording complete protection for every square mile of this country against damage from a surprise attack from the air by any direct method of defense now available.

But the job can be done *indirectly*. Suppose we build up and maintain and constantly improve a powerful retaliatory bombing force, and suppose we protect that retaliatory force so that it cannot be destroyed or seriously impaired. Under such circumstances an attack on us would be fraught with such risk—in this case, the risk of massive retaliation—that I am sure it would never be made.

This idea of defense through fear of retaliation is not just psychological in its import. It constitutes a real risk that any military tactician would weigh against the remote possibility of a quick victory by demoralizing our country with one all-out attack.

How can you and I help to bolster this threat to any potential enemy?

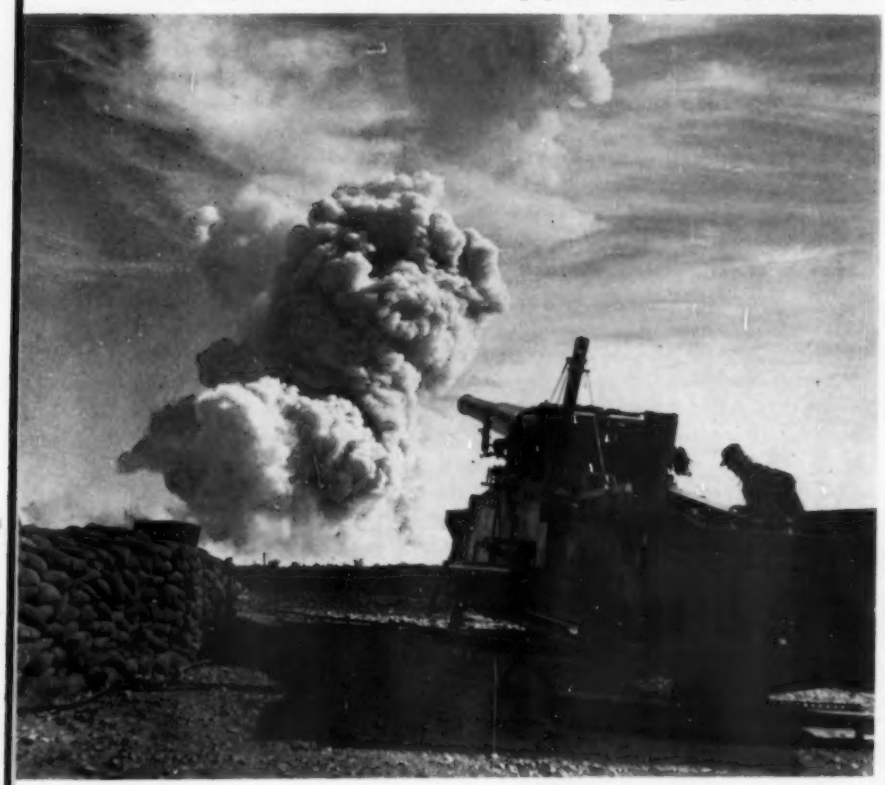
We can help, first, by coöperating with the authorities in Washington who are responsible for planning our defense program; by offering our ideas and our talents and our help in developing and in putting into effect the important industrial part of our over-all

defense program—for which I should like to substitute the name "war-prevention program."

The specific objective is that there be available, when needed, all the implements of war—guns, tanks, planes, ammunition, missiles, and a great variety of equipment—in quantities sufficient that all of them may be employed without stint in accomplishing what, unfortunately, we did not accomplish in our last military effort—a quick and decisive victory.

Secondly, we can help our military planners keep the risk in war if we will encourage the idea men who make up our research and development organizations to address themselves to the need for constant improvement in types of military equipment with which they are familiar—how they can be made better, how they can be made quicker, how they can be made cheaper, how they can be made more effective. Many important items of military equipment are in the same general categories as civilian equipment with which we have had a great deal of experience.

The 280-mm. gun capable of firing an atomic shell is only one of many weapons necessary to keep war with America too high priced for an aggressor (Army photo).



DESPITE the alarms and excursions which are reported in the news headlines almost every day, it is nevertheless a solid fact that we can and will prevent another general war simply by keeping high the risk for our opponent. In doing this, both you and I can play a not unimportant part.

Ten-Millionth of an Inch

Modern mass production depends upon accurate gaging for its interchangeability of parts, and preparations are now being made to calibrate master gages to a ten-millionth of an inch

Dr. Irvine C. Gardner

ONE could establish the hypothesis that there is a very close correlation between the material standard of living of a nation and the accuracy and precision of its gaging methods.

One can visit the royal coach house at Versailles or view the very large collection of royal and ecclesiastical coaches at Lisbon and realize that neither Louis XIV, reigning over the most cultured court in Europe, Napoleon Bonaparte, the leader of the most powerful army of the world, nor any other ruler of those times possessed a vehicle which for comfort, speed, or road competence is even worthy of comparison with our present-day motor car that is available to our average citizen.

The older coaches probably had no fit of mechanical moving parts that was as good as one one-hundredth of an inch, but our modern automobiles, cheaper in man-hours as is proved by their abundance, abound in tolerances that are measured in ten-thousandths.

The modern abundance of precision low-cost mechanisms could not have been achieved without production methods utilizing interchangeable parts, and this, in turn, could not have been achieved without modern precision gaging methods.

NOT only was the eighteenth century characterized by a lack of precision of measurement in the industrial areas but the units of measurement also varied, not only from country to country but even within a single country.

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The need for greater uniformity of measurement had long been recognized by the scientific world and also by commercial and industrial interests. To meet this need the metric system was developed.

It is remarkable that the French undertook the scientific work which led to the establisment of the metric system of measurement near the beginning of the French Revolution and that the work was conducted with surprising continuity during the disturbed conditions of this period.

Although the French, from the beginning, hoped that the metric system would gain international acceptance, the new system found only limited application for about half a century.

In 1870 the first of a series of international conferences was held in Paris to consider the more general adoption of the metric system. As a consequence of this series of meetings the International Bureau of Weights and Measures was established, and the International Prototype Meter and the group of national prototypes were made, intercalibrated, and distributed.

The United States received its prototype, now in the custody of the National Bureau of Standards, in 1890. The International Prototype Meter, through the direct application of our national prototype, defines the yard and, consequently, the inch, which is the unit for precise measurement used by our mechanical engineers.

Hence, although our country and France do not employ the same units, the relationship between the metric and our own inch-unit system is precisely defined, and all industrialized countries have systems of measurement which are precise and which, within any given country, are applied with uniformity. Without such uniformity one could not have the production of interchangeable parts.

AT present there is not uniformity in the length of the inch in the different inch-using countries, but there is a probability that uniformity will be achieved and that the inch finally selected for use in all these countries will be defined in terms of the meter, in which case substantially all units of length will have been defined in terms of the same physical standard.

The development of a precise system of length measurement, although essential for precise gaging, does not, of itself, imply precise gaging. In my personal opinion, gaging is a more restricted term than measurement. Measurement may be of the scientific laboratory or of the workshop, but gaging is essentially of the workshop.

Measurement may utilize all the

facilities of the scientific laboratory, of scientific personnel, and considerable time, whereas gaging is measurement so simplified by instrumentation that the skilled artisan or craftsman can obtain results rapidly in the workshop and is thereby enabled to use it to exercise control while production is in progress.

A BIG advance in the art of precision gaging was inaugurated by the invention of the micrometer caliper. A micrometer caliper of the Système Palmer was patented in France in 1848. From photographs of this early instrument it appears that the least reading was 0.05-mm. (0.002-in.). In general form this first micrometer suggests our modern micrometer.

In 1867 Brown & Sharpe began the production of micrometer calipers in this country, and, today, the least reading may be as small as one ten-thousandth of an inch. In the United States the micrometer caliper remained typical of precise industrial measurement until World War I.

As an interesting digression, it was my good fortune to visit Germany shortly after the end of World War I, and naturally my interests took me to the firm of Zeiss in Jena. From one of this firm's foremost engineers, the man responsible for the development of their remarkable optical rangefinders, I learned that Germany, at the outbreak of the war, had no domestic source of micrometer calipers. Germany, the land of mechanical precision, had found this country such a satisfactory source of micrometer calipers that it had developed no domestic source of supply.

THE next revolutionary procedure in gaging took place as a consequence of the development and introduction of Johansson gage blocks. The first set of gage blocks was completed in Sweden in 1896, and it is recorded that a set was examined at the National Bureau of Standards as early as 1907, but the real impetus for the use of these blocks in this country came with World War I.

Individual gage blocks, each for a specific dimension, had been in use for many years, but the possibility of combining blocks to produce a precise new length was unique.

The military rifle was perhaps the first precise mechanism produced on a sufficiently large scale to justify interchangeable production and hence provided an urgent need for the development of exact gaging procedures. A new program for the manufacture of Mauser rifles in Sweden under a German license was the immediate stimulus for the conception of the new gage blocks.

The gaging length of each block was defined by two optically plane, parallel surfaces. The surfaces were so truly plane that when two blocks were suitably brought together they adhered by cohesion and could be handled as one element. Furthermore, the junction was so close that the combined length of the two blocks could be treated as identical with the sum of the individual lengths.

THIS combination principle was the feature that gave the gage blocks their great utility. With only 102 blocks it was possible to so choose the lengths that any length lying between 1 and 201 mm. could be assembled in increments of 0.01-mm. (0.0004-inch).

In order for the combination principle to be useful it was necessary that the lengths of the individual blocks be very accurately determined. The original blocks were correct to a few microns. The conception of a set of individual gage blocks of accurately determined lengths capable of being combined to produce precisely known lengths over a very large range of values was a brilliant one.

But for the success of this conception, it was most fortunate that the combination gage blocks from the time of their introduction were precisely shaped and accurate in length. For the set of blocks to be useful for forming combinations it was necessary that the end faces be optically plane, parallel, and well polished. It was also necessary that the lengths of the individual blocks be accurately known if the sums of the lengths of the combined blocks were to be useful.

IN 1902 four blocks from an early set were measured by the International Bureau of Weights and Measures at Paris and the errors were reported to range from 0.0002- to 0.0028-in. (0.6 to 7 microns), an accuracy which was considered remarkable at that time.

These gage blocks had one great advantage which the inventor could not have foreseen. The blocks, bounded by parallel, optically plane surfaces, proved to be especially suitable for measurement by interferometric methods.

The interferometer can be so readily applied that contemporary gage blocks are regularly measured by interferometers in terms of light waves.

A woodcut from a book published in 1575. Sixteen men, as they came from church, were arranged toe to heel and the over-all length of the 16 feet divided into 16 equal parts, thus giving an average value to be used as a measure of length.

Present-day commercial gage blocks in general do not differ from their nominal lengths by more than a few millionths per inch of length. One of the earlier publications of this country on methods of measuring gage blocks by an interferometric method was published by Peters and Boyd in the *Scientific Papers of the National Bureau of Standards,* Volume 17, page 693 (1922).

DURING World War I, a Major Hoke of the Army was assigned to develop a production method of manufacturing gage blocks embodying the combination principle. This work was done at the National Bureau of Standards, and the project was completed near the end of World War I.

It is believed that the original Swedish gage blocks were produced by handwork applied to each individual block, whereas by the new procedure a large number of gage blocks were lapped simultaneously to precisely the same length.

Line standards, which are our most accurate and precise standards of length and which by definition are still our authoritative and fundamental standards, cannot be calibrated by an interferometric method as readily and conveniently as can end standards of the gage-block type.

Conseqeuntly, as a result of the applicability of the interferometric method and the development of special interferometers for the convenient application of this method, a laboratory or a commercial firm can make use of wavelengths of light and, without recourse to a national prototype or calibrated line standard, can calibrate gage blocks with a precision and accuracy substantially equal to that attainable by a national laboratory making use of a national prototype—and with much less labor.

THIS has been a great boon to industry. It has provided gages calibrated with an imprecision of one or two parts per million (even less imprecision is attainable by special work) and for most purposes the gages of industry are now controlled as though a wavelength were our standard of length.

It has now developed that for certain applications of surface grinding the accuracy and precision of execution has attained such perfection that an imprecision of less than one millionth per inch is desirable. This, of course, does not signify that surfaces are being ground with an imprecision as small as one ten-millionth or even as small as one millionth of an inch.

The echelons of gages remind one somewhat of the house that Jack built. The most precise gaging procedure, which may in fact be a procedure of measurement, is used to calibrate the super super gage, which in turn is used to calibrate the super gage, and so on down to the gage that is directly used to control the finished product.

If this last gage is to be used with confidence to measure ten-thousandths, experience has shown that the national laboratory must calibrate to millionths. If industry is to proceed beyond ten-thousandths, a precision for which a demand has already been expressed, the national laboratory must calibrate to ten-millionths.

Spectroscopists regularly make comparisons of wavelengths of different spectral lines with an imprecision not exceeding one or two parts in fifty million. This is possible because the wavelengths being compared are similar in character and are affected almost equally by changes in the ambient conditions.

THE metrologist has to make a comparison between a wavelength and a material gage. The material gage and the wavelength are affected very differently by changes in the ambient conditions and have characteristics that differ greatly.

Hence, an imprecision of one or two parts in fifty million is not at present attainable in the calibration of gages. An imprecision of one part in ten million is believed to be possible by procedures that can be reasonably well appraised in advance. Much of the improvement in the precision will come from more adequate control.

As a part of the preparation for an attempt to make available measurements accurate and precise to one or two parts in ten million, an examination has been made of the possible sources of systematic error. Many of these have been of such interest and importance in showing the difficulty of the proposed measurements that it has been thought worth while to show them diagrammatically with adequate descriptive legends (see pages 899-901).

After these illustrations of the rigorous control that will be necessary if one is to measure to one part in ten-million, it will be something of a relief to observe what was done before we had interchangeable manufacture and national standardization laboratories.

The picture on page 897, from a woodcut of 1575, illustrates the derivation of a standard foot. Sixteen men were selected as they came from church (good men make good standards) and caused to stand toe to heel as shown in the woodcut. The total length was then divided into sixteen equal parts to define the foot unit.

IN a hotel at Innsbruch, Austria, I recently saw a reproduction of an old map of the Tyrol made in 1774. It had several scales of miles, each divided into feet. However, there were two kinds of feet, the Vienna work shoe and the Innsbruch work shoe. The complete legend, freely translated, follows:

"The first map of Tyrol, by Peter Anick. Prepared on contract for Kaiserin Marie Theresia in 1774. Scale of miles;

"The common German mile of which 15 are equal to 1 degree on the equator, subdivided into 23,524 work shoes of Vienna and subdivided into 22,272 work shoes of Innsbruch.

"The Great German Mile of two stunden, 32,000 Innsbruch work shoes long.

"The Italian mile, of which sixty equal one degree on the equator and which is equivalent to 5,881 Vienna work shoes or 5,568 Innsbruch work shoes."

From this it is interesting to note that they had government contracts even in 1774 and that at this comparatively recent date, even for so small a country as Tyrol, the lack of uniform practice in measurement was so great that several scales of distance were required for the most routine purposes.

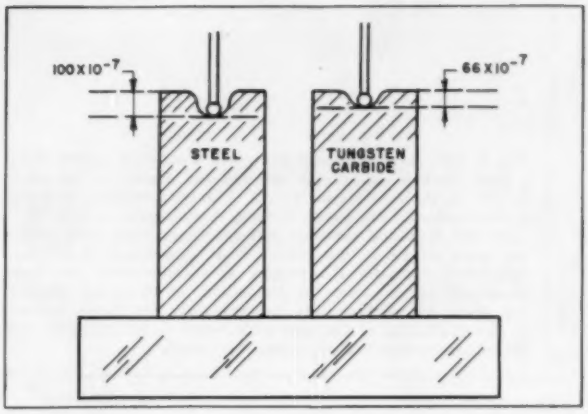


Fig. 1, left. Two gages of equal length but of different materials, one of steel, the other of tungsten carbide, are shown being compared by a mechanical gaging device. The plunger of the mechanical gage is provided with a diamond tip of ⅛-inch radius and the pressure is 6.4 ounces. (These values are those applying to a typical comparator.) In the steel gage the penetration is 100 ten-millionths of an inch, and for the carbide gage it is 66 ten-millionths. The mechanical comparator, therefore, will show an apparent difference of length of 34 ten-millionths for gages of these differing materials. For fused quartz the penetration would be 200 ten-millionths of an inch.

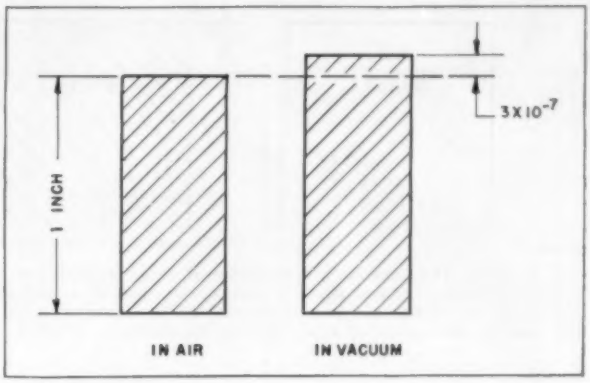


Fig. 2, right. For some purposes when an interferometric method is used it is convenient to measure a gage in a vacuum. When this is done, to determine the equivalent length in air it is necessary to make a correction for the expansion of a gage that occurs as the pressure of the atmosphere is removed. For a one-inch gage of steel this change in length amounts to 3 ten-millionths. For a gage block of fused silica the corresponding expansion in length would be 9.9 ten-millionths. For details of experimental work see account by Emerson, *Journal of Resources of the National Bureau of Standards, 18,* 683 (1937).

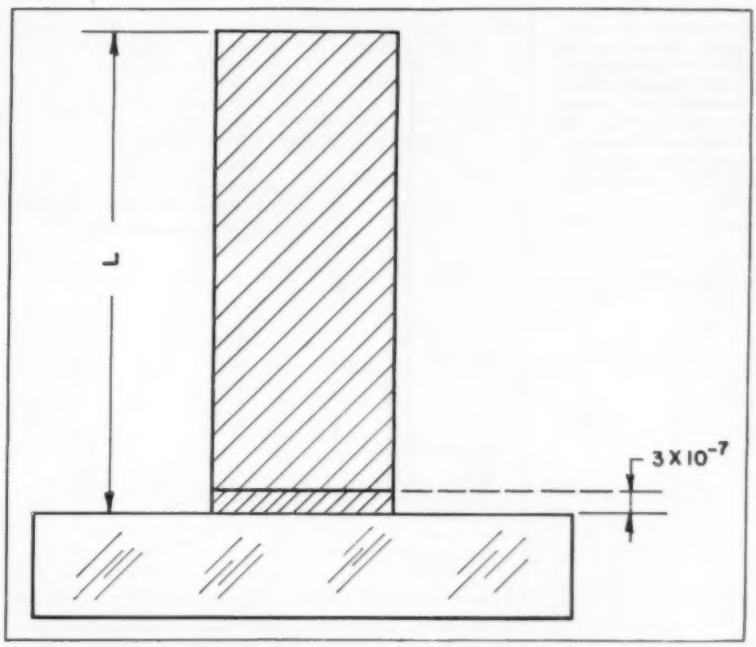
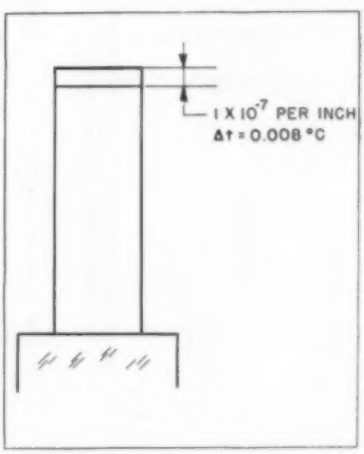


Fig. 4, above. A gage is shown wrung to a base plate for measurement. The wringing interval depends upon the character and planeness of the two surfaces. An average value for the interval is 3 ten-millionths. A gage length is defined as the length *L* which is equal to the geometric length of the gage plus one wringing interval. For the length of the gage to vary not more than plus or minus one ten-millionth the wringing interval must be reproducible within this tolerance. To keep safely within this tolerance it will be desirable to have surfaces more truly plane than those on present commercial gages and a well-regularized procedure for wringing.

Fig. 3, below. The coefficient of expansion of steel is approximately 12 x 10^{-6} per degree centigrade. A change of temperature of the steel of 0.008-degree C. will cause a change of one ten-millionth in a one-inch gage. For fused silica the coefficient of expansion is only 0.25 x 10^{-6}. Consequently a change of temperature of 0.4-degree C. would be required to produce a change of one ten-millionth in a one-inch gage. For industrial purposes this very small coefficient of expansion is not necessarily advantageous as it is often desirable to have the coefficients of expansion the same for the gage and the object to be gaged.



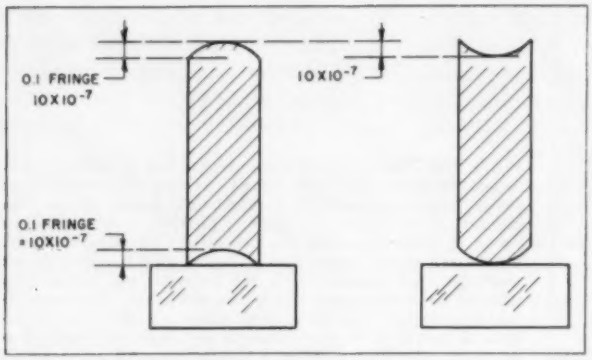


Fig. 5, left. A somewhat naïve picture of what occurs when a gage block is concave at one end and convex at the other by 0.1 of an interference fringe. The measurement is made at the center of the upper surface. A difference of 10 x 10^{-7}-inch will be found between measurements made with different ends wrung to the block. This representation is oversimplified. Actually if wringing is accomplished, the base plate will curve somewhat, the extent of curvature depending upon its thickness, to accommodate its upper surface to the curvature of the end with which it is contacted and larger errors than that indicated may result.

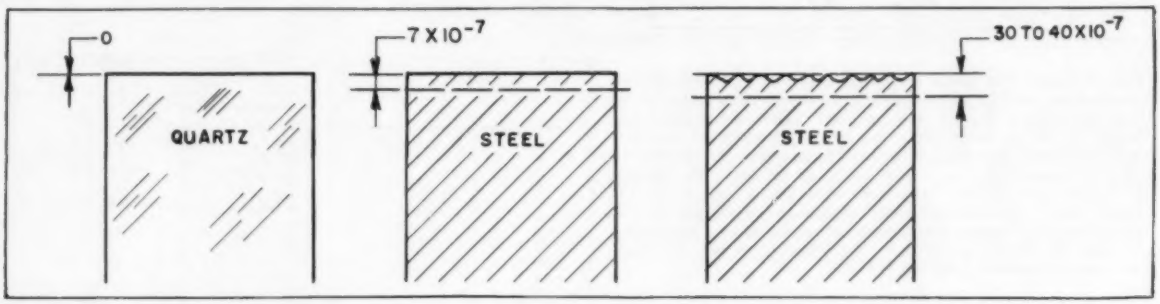
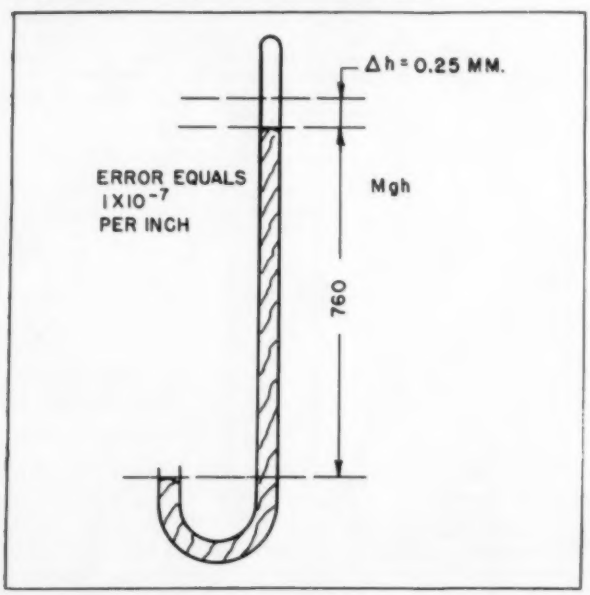


Fig. 6, above. The variation of the change of phase on reflection for different materials is indicated. As has been mentioned, the change of phase for fused silica, a transparent material, is negligible. For a perfectly polished piece of steel, because of the light absorption the change of phase is approximately 7 ten-millionths of an inch. For the usual gage surface which appears polished but actually has numerous small defects, the change of phase is increased as though the depths of the depressions were averaged.

Fig. 7, below. When the length of a gage is measured by comparison with wave lengths in air it is necessary to know the index of refraction of the air because the wave length changes as the index of refraction of the air changes. The index of refraction of the air, in turn, changes as the barometric pressure changes. When making interferometric measurement in air, therefore, it is necessary to know the barometric pressure and apply a correction if the barometric height differs from 760 mm. An error of 0.25-mm. in the measurement of the height of the mercury column of a barometer will result in an error of one ten-millionth per inch of length in the final length measurement of the gage.



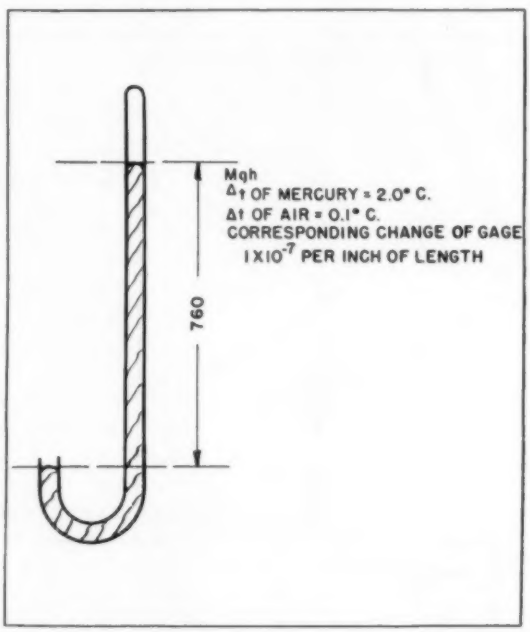


Fig. 8, above. To give the true value of atmospheric pressure it is also necessary that the reading obtained directly from the barometer must be corrected for the temperature of the mercury in the barometer column. An uncertainty of 2 degrees C. in this temperature will introduce an error of one ten-millionth per inch of gage length. The index of refraction of air, and hence the wave length of a standard radiation, is also affected by the temperature of the ambient air. An error of 0.1-degree C. in air temperature will introduce an error of one ten-millionth per inch of gage length.

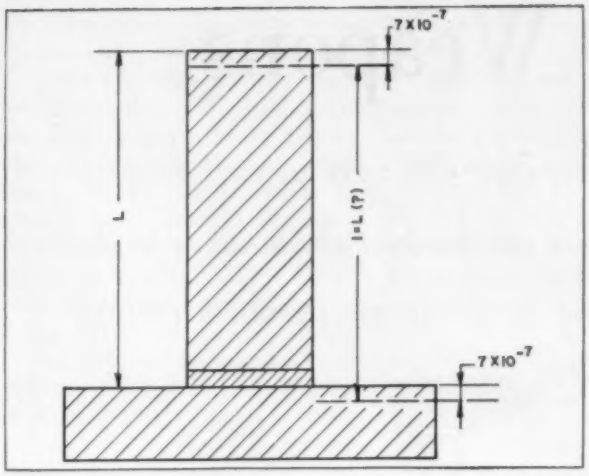


Fig. 9, left. When measuring a gage interferometrically the light acts as though it penetrates into the gage. This is referred to as the change of phase that accompanies reflection at the surface of a light-absorbing material. This effect somewhat resembles that due to the penetration of the plunger of a mechanical comparator but the optical effect is less than one one-hundredth of the mechanical penetration. Under favorable conditions the change of phase for steel corresponds to a penetration of approximately 7 ten-millionths. If the surfaces of the gage and of the base piece introduce the same phase change the two compensate and no error is introduced. For a transparent substance, such as fused quartz, the light absorption is small and the change of phase is negligible.

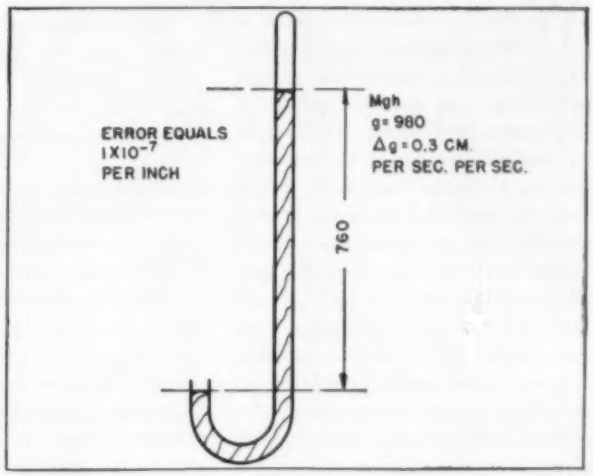


Fig. 10, right. To determine the true barometric pressure it is necessary that the direct reading of the height of the mercury column be corrected for the departure of the value of g, the acceleration due to gravity, from its standard value. The standard value is 980.665 cm. per second per second. An error of 0.3-cm. per second per second in this value will introduce an error of one ten-millionth per inch. Values tabulated for different locations within continental United States show a total range of approximately 1.7 cm. per second per second. Therefore for two points within the United States it would be possible to obtain differences in lengths measured by an interferometric method amounting to 5 ten-millionths per inch of length if the barometric reading is not corrected for the local value of gravity.

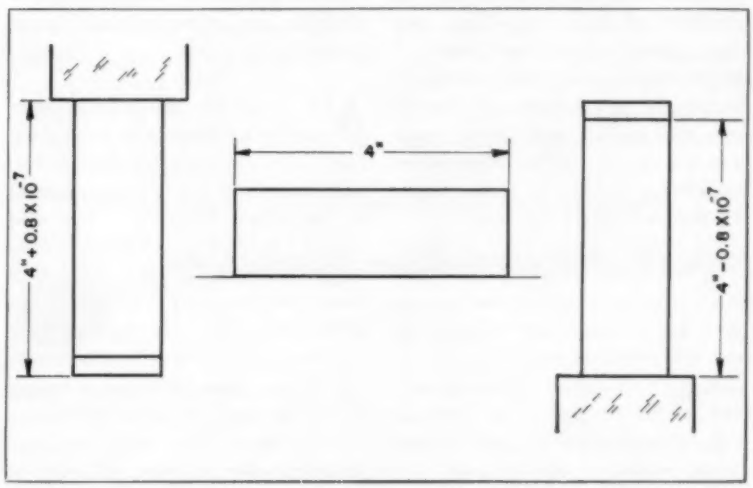
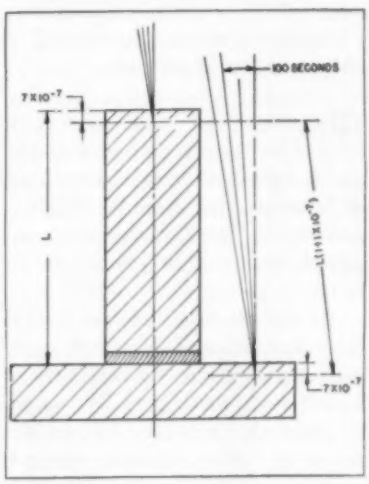


Fig. 11, above. The central drawing shows a 4-inch gage resting on a flat horizontal surface. If the gage is supported by its upper end, as shown at the left, its length will increase nearly one ten-millionth (0.8×10^{-7}) of an inch because of its weight. Similarly if supported on its lower end, as shown at the right, its length will shorten the same amount. This elongation and shortening varies as the square of the length. Consequently for a one-inch block the change in length will be half of one hundred-millionth and quite negligible for our present purpose.

Fig. 12, below. A 4-inch block is in position for an interferometric measurement. The pencils of rays shown are not normal to the block and base but are inclined. If the angle of inclination is 100 seconds, an error of one ten-millionth will be introduced for each inch of length.



Colonial Weapons

The wheel-lock caliver and the frontier rifle were as well adapted to the needs of early America as our modern ordnance is to the requirements for national defense in the atomic twentieth century

Jac Weller

WE think of our colonial forebears as using only firearms in their fighting. That's largely correct. Yet for a century following the establishment of the first colony of Englishmen in America, both the pike and body armor played an important part on European battlefields. Edged weapons were used decisively in war over there in the nineteenth century.

However, notwithstanding the various engravings found in history books showing armor, staff weapons, and even crossbows, the North American colonists relied almost completely on their muskets and fowling pieces.

There were several reasons for this early and typically American approach to ordnance matériel. First, armor and the accompanying offensive weapons were expensive. The colonists were poor; the companies that sent them out were in business for a profit. A musket or caliver was cheaper than the equipment used by a pikeman—half-armor, a helmet, and at least a broadsword in addition to the 18-foot pike.

SECONDLY, a man carrying a musket was far more mobile and able to fight much more effectively out of formation. The New World put a premium on mobility; the rough uncleared country made formations difficult.

Thirdly, the main potential enemy, the Indian, did not fight in such a way as to require the defensive power against shock attack given by a hedge of pikes. Our ancestors defeated the savage by almost equaling his maneuverability and greatly exceeding his firepower and discipline.

Mr. Weller is a well-known authority on American ordnance of the colonial and Civil War periods.

This firepower came mainly from shoulder weapons of two general types: the numerous smoothbore muskets and fowling pieces and the relatively scarce rifles. The early seventeenth-century rifles shot well but were costly, slow to load, clumsy, and delicate. They weren't common in America.

Even the legendary eighteenth-century rifleman of the leather-stockinged type was relatively rare. These men never formed a very large portion of the population. The rifle carried by them in the eighteenth-century, though light and graceful and usually made here, was not only far too expensive for the average colonist but also fragile and required skillful handling.

The average farmer (even as late as 1775, the farmer composed more than ninety per cent of the colonial population) had a smoothbore weapon. He was accustomed to using his arm almost every day in his fight to provide food for the members of his family as well as occasionally to protect them against human enemies.

However, before concentrating on this main ordnance form, let's take a brief look at other European arms used to some extent in America by the British and Dutch colonists. In general, the Spanish to the south were military conquerors rather than colonists. Their ordnance, though quite different from the British and Dutch, did not add greatly to our heritage. The French, on the other hand, followed a pattern in arms very much like that on the Atlantic seaboard.

As regards armor, breast and back plates, together with the large thigh guards associated with the seventeenth-century pikemen, did exist in the colonies. Perhaps lobster-tail helmets and morions, common in the English Civil War, were brought to this country in even greater numbers. However, these things must have soon become more or less garrison ordnance. It's difficult to visualize a group of Englishmen in a Virginia summer wearing such paraphernalia.

ALL forms of staff weapons were mainly for show or garrison duty. Lord Delaware, while Governor of Virginia in 1610, was usually accompanied by halberdiers. However, a man who carried a halberd in a wilderness campaign against the Indians would have been unable to carry a firearm. Some of the colonies had laws requiring every man to keep a firearm in good condition at all times. A range exceeding that of the savage's arrows, which was probably about thirty yards, was more important than extreme lethalness at close quarters.

Edged weapons were common in colonial times. However, those used over here were rarely more than knives. The length of swords was against their

use. Even bayonets, in common use in Europe after 1700, didn't find much favor here. From the very beginning, our ancestors seem to have preferred to use the butt end of a musket that they had to carry with them anyway, rather than to impede their progress in the forest or on the battlefield with a long sword blade and sheath hanging down beside their legs.

Adding the inconvenient length of a bayonet to an already overlong musket barrel was also avoided. However, the knife and the personal tactics of its use reached a degree of deadly perfection in the hands of colonial Rangers never exceeded before or since.

The knives carried by George Roger's men were largely made here of one general pattern but according to individual taste. One of these weapons was the model for the British Commando dagger of World War II.

HAND firearms seem to have been well received where they were available. Pistols were certainly popular among the wealthy in Colonial America. They were probably more common here than in Europe in proportion to the population. However, they were extremely expensive and relatively delicate. The larger varieties were bulky and heavy for carrying long distances on foot.

Cavalry and cavalry weapons played a relatively insignificant part in our colonial ordnance. The great geographical distances and the love of horseflesh, particularly by the Virginians, led to an early development in America of horses and horse transportation. Many areas could be reached only by boat or on horseback.

The horse, however, was of small battlefield importance since there were few areas where fighting took place that were sufficiently clear to allow for mounted maneuver. Horses were handy for pursuit and retreat, but hard fighting was done mainly on foot. Further, the accuracy of colonials with firearms prevented most men from wanting to form in a compact mass and endeavor to use cavalry weapons at close range.

Field artillery was also of small importance, though its seacoast counterpart was present in all the early colonies. Seven years after the founding of Plymouth, the Puritans were in possession of at least ten cannon strategically mounted to defend the colony. One of the first buildings at New Amsterdam was a fort containing heavy artillery. Jamestown had its batteries of relatively powerful immobile cannon. All these pieces were too heavy for use in the field.

In the seventeenth and eighteenth centuries in Europe small cannon were frequently attached to or made part of infantry battalions. Apparently, this practice was not often followed in the colonies because of the difficulty of transporting even 3-pounders through the wilderness.

One company of English artillery did accompany Braddock on his ill-fated expedition against Fort Duquesne in 1755, and a great many guns were used in the sieges of Louisburg which finally fell in 1758. However, this latter was siege artillery dragged slowly about at the expense of tremendous muscular effort by man and beast.

Let's return to the main ordnance form. Shoulder weapons were used almost exclusively as offensive arms. The colonials early developed not only tactics for their use under New World conditions but to some extent changed the matériel itself. Colonial firearms differed considerably from those used in Europe at the same period.

There are two fairly well defined phases in colonial shoulder weapons. The first extends from the establishment of the colonies to about 1700. Surviving specimens of this period are extremely scarce. These arms were made in Britain and the Low Countries, for very few firearms were made in the colonies in the seventeenth century.

Queen Anne musket probably restocked in Boston (Smithsonian photo).

Regardless of origin, all these were nonstandard weapons with many variations even between successive pieces from one gunmaker. There were, however, general resemblances within specific types. Arbitrarily, this period can be said to have come to an end about the time that Americans began to receive the more or less standardized weapons with which William III equipped the British Army.

AT the beginning of this early period, the matchlock musket-caliver was far the most numerous arm both in Virginia and Massachusetts. It had on the right-hand side of the breech a pan containing the priming charge. Forward of the pan was the cock carrying several feet of niter-impregnated cord called "match" smoldering at both ends. Pressing the lever or trigger caused one of these glowing ends to descend on an arc into the pan and set off the gun.

This ignition system was simple, hardy, and cheap to produce. Once the ends of the match were going, and if the weather was good, it worked surprisingly well. If the infantryman was sufficiently well trained to keep his match properly adjusted in the cock and aglow (the business end was frequently blown out upon discharge and had to be relighted with the other) this arm would probably fire more rounds between cleaning than any other.

It had, however, many disadvantages. Foremost of these was the time neces-

Matchlock musket of the early colonial period (Smithsonian photo).

sary to kindle the match and get it going well. This was obviously a great disadvantage in Indian fighting. The matchlock was useless in wet weather. Several matches sputtering together produced such a noise and smoke by day and noise and glow by night that surprise was impossible.

These military matchlock arms were of two general types. The term "musket" then meant a weapon of very considerable weight and length requiring a rest for its precise operation by a man of ordinary strength. The caliver, on the other hand, was a lighter weapon of smaller bore, although it was usually a full five feet long. It could be handled without a rest and was easily fired from the shoulder. There were, of course, sporting arms of varied types and sizes. Even early in the seventeenth century most of these used other ignition systems.

Rare wheel lock infantry musket made in the Netherlands about 1620.

THERE were two other ways of setting off the priming charges in these sporting weapons. Both had been employed for some time and were occasionally used in military arms. One was the spinning of a serrated steel wheel in contact with iron pyrites to produce a large volume of sparks. This was the wheel lock. They were expensive to produce, reasonably delicate, and seldom issued to common soldiers in European armies.

The wheel lock was much quicker to get into operation than the matchlock since it could be carried, loaded, and primed with the wheel spring fully wound up. It was ready to fire at the touch of the trigger release. The wheel lock was reasonably weatherproof for the first shot; however, continued firing without cleaning soon jammed the wheel.

The other system of nonmatch ignition was the striking of a blow with flint against steel to produce a smaller volume of sparks which was found adequate when properly directed into the pan containing the priming. The wheel locks were all of one general type; there were at least three types using flint.

Research in colonial records is complicated by the fact that the words used do not convey any definite picture in our minds today. Anything other than a matchlock was referred to as a "firelock." The word "snaphaunce" seems to have been used in somewhat the same sense.

Today, however, we designate a certain type of early flint-and-steel ignition by the term snaphaunce—that having the vertical steel piece, or frissen, upon which the flint strikes, separate from the pan cover.

The doglock, or English lock, had the frissen and pan cover in one piece, which simplified both manufacture and discharge. It had, however, a sear extending through the lockplate to engage the cock directly. It usually had a safety catch or "dog catch" engaging the cock at the rear.

A somewhat similar lock is known as the miguelet or Spanish lock. Finally, there was the true flintlock with one-piece frissen and pan cover and internal sear.

Matchlocks were more numerous at first in the colonies. However, they rapidly fell into disfavor. By 1625 the matchlocks in Virginia had been largely replaced by various flint forms. The wheel lock, while in use for many years, was too costly ever to be the most numerous type.

IN Massachusetts, where all colonists were required by law to be armed, private individuals could continue to keep matchlocks until 1677, although public arms had for some time consisted of firelocks only.

Most firearms over here before 1700 were smoothbore muskets, calivers, or fowling pieces using one of the ignition forms already discussed. However, as already mentioned, there were some rifles. These were particularly significant in that they lead to the first complete typically American weapon.

First in New York and later in Pennsylvania local smiths began to modify the imported German and Dutch rifles and to build new ones. The barrel was lengthened and the bore reduced. The stock was made light and graceful.

Most important of all, the rifles were easily loaded with lead bullets of less than bore size encased in leather or cloth patches. These weapons, because of their lightness and the even more important lightness of their ammunition, were perfect for conditions in America at the time. The weapon was accurate to 150 yards, reasonably powerful, and reliable in skillful hands.

THESE rifles were the first firearms produced in quantity in the colonies. In general, the locks were imported from Britain, the stocks fashioned here from native wood, and the barrels forged, finished externally, and rifled by the local gunsmith. They were first class and ideal for the purposes for which they were used.

There were also in the colonies a small number of firearms of other types such as English-made breechloading stalking rifles. This was a period of experimentation in England. The wealthier Virginia planters were likely to buy the newest thing in arms and try it out whether it worked well over here or not. However, these weapons played little part in our history and none at all in the development of our ordnance.

By 1700 the colonies as a whole were no longer in danger of being overrun by Indians, though local attacks were

not uncommon in exposed sections. They were emerging as a people with established governments. The militia was always a very important part of most of the colonies and received the careful attention of the governments both here and in England.

In 1688, James II fled England and William III of Orange came to the throne after almost negligible resistance both over there and in the colonies. The new monarch was a good ordnanceman as well as capable and meticulous, though not a brilliant military commander. Under him, the British Army was for the first time reasonably uniformly equipped.

He introduced a new musket with a true flintlock, although often equipped with a dog-type safety catch. It weighed about 10 pounds, had a 46-inch barrel with a caliber .76 bore, and took a plug bayonet. Its barrel was painted black.

The most important point about these arms was that they were reasonably uniform throughout the army and that, finally, the true flintlock was universally adopted for line infantry use. The whole weapon was substantial, solid, and reliable.

THESE new weapons could not have reached the colonies much before 1700 since the army at home came first. However, relatively large quantities were sent over in the early years of the eighteenth century, for the War of the Spanish Succession had its New World phase as well as that in Europe where Marlborough won lasting renown.

These William III-type muskets continued to be made with little change throughout the reign of Queen Anne (1702-1714) and into the reign of George I (1714-1727). They were the basis of Marlborough's victories in Europe and continued to be used over here for many years, both by the militia and by private individuals who purchased or otherwise obtained them. As many survive in America as in Great Britain.

A new and quite different musket now called the Brown Bess began to supersede that of the general William III pattern about the middle of the reign of George I. This new and slightly lighter weapon is said to have been "invented" by Marlborough early in Queen Anne's reign.

This story seems unlikely, however, since the earliest dated specimen known to the writer is 1717. No Brown Bess musket bearing Queen Anne's cipher or dates appears to have survived, whereas very many weapons of this period have survived which are not of the Brown Bess type.

The new Brown Bess muskets went a step further toward standardization. They are as much alike as the methods of manufacture would allow. The barrel length and bore—46 inches and caliber .76—remained the same. The form of stock, lock, and mountings changed considerably. The barrels were pin-fastened to the stock with a long screw securing the breech-plug tong to the trigger plate.

These were the first muskets of regular issue to take a bayonet mounted on the outside of the barrel so that the arm could be fired with the bayonet in place.

At first, these arms were sometimes made with iron mountings. Later they were turned out with the more common brass fittings exclusively. Very few brass-mounted Brown Bess muskets have survived which were made during the reign of George I. There are, however, a good many typically Brown Bess muskets with iron mountings dated around 1722.

At any rate, a standardized musket, either brass- or iron-mounted, did come into general use in the British Army about 1725. These weapons began to appear in this country and replace all other arms in the hands of the colonial militia shortly after that date. This arm with but a few relatively minor changes, such as reducing the barrel to 42 and then 39 inches, continued to be the standard weapon of the British infantry for over 100 years.

IN the 10 years preceding Waterloo, England produced 3,000,000 of them. They were almost the only military arm in the colonies until the Revolutionary War.

Quite naturally, when the Revolution became inevitable, the colonists copied the Brown Bess in the new arms they made to gain their freedom. These weapons, made by many colonial gunmakers, were called Committee of Safety Muskets. These small shops had been reasonably active for some time. They had made mainly the American rifle, though smoothbores were also produced.

Early Brown Bess iron-mounted musket made in England about 1722.

The American rifle had been first rate for hunting and Indian fighting in the wilderness, but as a standard military arm, it was poor. It was slow to load, delicate, did not take a bayonet, and did require great skill and experience for a man to use it successfully.

The British Army was sufficiently impressed by rifles in general, however, to begin to use them fairly extensively. Eventually, they formed their rifle brigade in part to succeed American colonials originally enlisted in their army as riflemen over here.

Colonial ordnance seems by modern standards extremely primitive and simple. The musket which was the major arm of almost all forces, large and small, from the settlement of Jamestown in 1606 until long after the battle of Lexington in 1775, seems singularly lacking in firepower. However, with it and the American rifle Anglo-colonials built from scratch in less than a century and three-quarters a nation to be reckoned with in the world.

Month by Month: Highlights of the National Defense

Air Force Missiles

The Assistant Secretary of the Air Force for Research and Development, Trevor Gardner, recently declared that "it is my feeling that the guided missile —and the kind of destructive force it can carry—forecasts, perhaps more than any single item in our military arsenal, what the Air Force of the future will be like—the 'shape of things to come' if you will, in our defensive and offensive power.

> *"The era of the unmanned missile in warfare is very much at hand," he continued, "and more and more, as technology progresses, the impact of the guided missile on our military, scientific, and industrial planning and organization is going to be felt."*

In his report on guided-missile activities, Mr. Gardner cited the following revolutionary weapons:

Bomarc.—A long-range pilotless interceptor to meet the problem of distant interception of enemy bombers. Development tests are very encouraging. When ready for quantity production the Bomarc will be a very effective Air Force surface-to-air missile for air defense.

Falcon.—This air-to-air missile is "one of the most important contributions to the defense of the North American continent against air attack since the development of radar."

This lightweight missile—it weighs a little over one hundred pounds—can be carried in quantity in a one-man or two-man interceptor aircraft.

Falcon really works (see picture on the front cover of this issue). It has been knocking down jet drones even without benefit of an explosive warhead—drones which were maneuvering in simulation of enemy bombers and which could have been carrying the hydrogen bomb. Using an explosive warhead, virtually every hit is lethal.

Matador.—An improvement of our air offensive system. Fighter-bomber forces, although powerful, are somewhat handicapped in their ability to operate in darkness and in bad weather. To offset this deficiency the Air Force has chosen this guided missile to assist in this job.

Navaho, Snark, Atlas.—These missiles increase the long-range striking power of our Strategic Air Command. Each has an intercontinental atomic capability, although their over-all performance differs materially.

Probably the most important member of the family of strategic missiles is the intercontinental Atlas.

Rascal.—An air-to-ground strategic missile now in the development stage. Designed to be carried aloft by our long-range bombers, Rascal will enable these bombers to deliver their nuclear weapons against an enemy who is many miles away.

Submarine Progress

The successful trial tests of the atomic-powered submarine NAUTILUS—the first of seven such craft either under construction or authorized—focuses attention on recent Navy development of powerful underseas craft.

> *A nuclear propulsion plant now makes it possible for a submarine to travel completely submerged at relatively high speeds for an almost indefinite period.*

Since World War II, the Navy has built a few so-called "submarine killers" or antisubmarine submarines. These are small craft of less than 900 tons' surface displacement and about 196 feet long. They carry the latest detection devices and are relatively free of engine noises. An additional asset is that they are highly maneuverable.

A number of wartime GATO class of fleet submarines have been converted to antisubmarine warfare duties.

The experimental submarine ALBACORE, designed without torpedo tubes, has a surface displacement of about 1,300 tons. It was built for high cruising speed under water. Not altogether satisfactory on the surface, it has achieved remarkable results when submerged.

Submarines have also been designed for the primary purpose of serving as a missile-firing platform. Development work is still continuing in this new field, both as to the submarine itself and the missile best adapted for sea-raider work.

> *Two radar picket submarines, displacing 1,500 tons each, are now being built. They are powered with conventional Diesel engines for surface use and with electric batteries for underwater travel.*

One experimental midget submarine is under construction.

The Navy is likewise building several attack-type submarines of the improved TANG and TRIGGER class adaptable to fleet operations, commerce raiding, or minelaying. Conventionally powered, they are of some 1,850 tons' displacement.

The submarine fleet of tomorrow will probably include four main types of functional undersea craft—the antisubmarine submarine; the missile-firing submarine; the radar picket submarine; and the fleet or attack submarine. It is quite likely that some of these ultramodern submarines will be nuclear-powered.

Other specialized types of submarines, such as the cargo carrier, can be converted from conventional fleet types.

Essential Occupations

Reflecting changes in the economic and military situation since 1950, the Government has revised and shortened its lists of essential activities and critical occupations.

> *The purpose of the lists is to assist in the equitable distribution of manpower among the armed services, defense production, and the civilian economy.*

The lists are used by the Defense Department in making determinations of requests for delay by Reservists who have been called to active duty. Local draft boards also have these lists available.

The original lists included 25 essential activities and 62 critical occupations, compared with 10 essential activities and 32 critical occupations on the 1955 lists.

To qualify for the lists under the foreseeable mobilization program, the activity must be necessary to the defense program, or to basic health, safety, or interest; or inadequate to meet defense and civilian requirements because of manpower shortages; or one for which the future manpower supply is not reasonably assured.

Here is the list of currently essential activities:

Production and maintenance of aircraft and parts; ship and boat engineering; ordnance; precision apparatus and scientific glassware; production of electronic and communication equipment; production of chemical and allied products; water and sewerage systems; health and welfare services; educational services; and research and development services.

The list of currently critical occupations follows:

Aircraft and engine mechanics; apprentices in critical occupations; chemists; clinical psychologists; dentists; die setters; electronic technicians; engineer draftsmen; design engineers; foremen in critical occupations; geologists; geophysicists; glass blowers; laboratory apparatus; instrument repairmen; jig and template makers; machinists; mathematicians.

Also microbiologists; nurses; orthopedic appliance and limb technicians; osteopaths; parasitologists; patternmakers; pharmacologists; physicians and surgeons; physicists and physiologists; vocational and college teachers; high-school mathematics and physical and biological science teachers; tool and die designers; tool and die makers; and veterinarians.

The New Rifles

The announcement by the Army that it will conduct all-weather tests of a new rifle system brings to mind the unsettled question of several years standing: What rifle will be adopted for the NATO forces?

The British, much to the surprise of many observers in the United States, adopted the Belgian FN, known here as the T48. In the minds of some people this decision is but one step removed from forcing the United States to adopt it, too. The FN along with others has been the object of extensive testing for years without a decision.

> *The all-weather tests will be undertaken by our forces using 500 FN rifles made by Harrington & Richardson and 500 T44 rifles, known as the "modified Garand," made by Springfield Armory. (For details of these rifles, see the article on page 1002 of this issue.)*

In the meantime the NATO gun controversy continues. In *Guns* magazine for May 1955 the lead article is headed "The Great Rifle Controversy" and has for its theme the proposition that the FN, adopted by the British and alleged to be a "shoo-in" for adoption by the United States, is similar to the Russian Tokarev. This rifle was tested and abandoned by the Russians several years ago, after its failure to perform satisfactorily in frigid areas.

American genius in the gun-design field has not had a chance to be heard, nor have the production abilities of American manufacturers been allowed to bring their forces into play. This matter should not be disposed of carelessly, and the action taken by the Army points to a clean decision, based upon comprehensive tests. Our Army would do well to avoid a "shoo-in" at all costs!

For a Strong Army

Gen. Matthew B. Ridgway, Army Chief of Staff, recently told a congressional committee that the Army should be kept strong.

He recalled that Communist forces have not undertaken armed aggression in any area where the United States forces were deployed.

> *This should make it obvious, General Ridgway said, "a primary means" of halting aggression is to keep "combat ready U. S. Army forces in sufficient strength, suitably deployed, with adequate air and surface transportation and support, for commitment at any threatened point."*

None the less, Army Secretary Robert T. Stevens supported the Administration's plan to cut the Army, saying that forces could be rushed overseas "in case of emergency."

The Army has designated seven posts as the permanent home stations for sixteen divisions involved in its new unit-rotation program.

The program, called Operation Gyroscope, is scheduled to start this summer. Its purpose is to rotate whole divisions and a few smaller units between home and overseas posts.

Under the new arrangement, which will replace the old one of rotating individuals, men going abroad with a division will know they will return to the same base.

The permanent home stations announced by the Army are: Forts Riley, Kans.; Lewis, Wash.; Ord, Calif.; Hood, Tex.; Campbell, Ky.; Benning, Ga.; and Bragg, N. C.

Except in the case of the 1st and 10th Infantry Divisions at Fort Riley, the Army did not identify the divisions that will call the various posts their home stations.

Unit rotation will start in July with the 10th Infantry Division replacing the 1st Infantry Division in Wurzburg, Germany.

Civilian Defense

Previous industrial-dispersal plans are obsolete.

In those far-away days, when there were only "small" atom bombs, the theory of the mileage yardstick made considerable sense. This theory dictated that new defense works were to be located not less than ten miles beyond the perimeter of industrial and population centers.

> *But the recent Atomic Energy Commission report indicates that radioactive fall-out resulting from a hydrogen bomb of the size tested a year ago in the Pacific could seriously threaten 7,000 square*

miles—an area as large as New Jersey.

The latest Administration proposal is that Congress authorize immediately a special commission on civilian defense so that legislation on industrial and other dispersal problems might be enacted in the present session.

There are few champions of the idea of industrial dispersion today because it would cost a fabulous amount of money, would cause severe urban and economic dislocations, and would weaken, rather than strengthen, our present national-defense structure.

As a consequence, Dr. Arthur S. Flemming, director of the Office of Defense Mobilization, seems to favor express highways to speed evacuation, school shelters, and the coördination of hospital and related programs.

Other observers have called for an effective air defense, the construction of shelters for workers and their families, and perhaps rebuilding plants underground.

The Army recently disclosed that casualties from the heat of an atomic explosion might be cut as much as seventy-five per cent by smoke screens.

Maj. Gen. William M. Creasy, Army Chief Chemical Officer, said that it was possible to use two kinds of smoke for city defense. One is artificial fog produced by heating oil and passing its vapor into the air, where it condenses. This type causes radiation to scatter as headlight beams do in a fog.

The second method is to use carbon smoke, familiar in every industrial city as smog. This smoke, which can be induced by the improper operation of both coal and oil burners, is the type that was tested in Nevada this year. It absorbs radiation.

No one should be discouraged if civilian defense plans soon become obsolete because of the current rapid advances being achieved in science and technology. What is obviously needed is a speed-up in civil-defense planning and better liaison with the Atomic Energy Commission.

Dr. John C. Bugher, head of the AEC's division of medicine and biology, recently stated that 300 persons had been injured by radiation in the March 1, 1954, hydrogen bomb test in the Pacific—in addition to some Japanese fishermen. Of these, eighty-four persons were subjected to severe exposure but all recovered.

Hysteria and reckless pronouncements solve few problems. But a commission of level-headed experts, carefully studying the immediate civil-defense problem, should be able, within a reasonable time, to come up with a few good, if only temporarily valid, answers.

Repackaged Divisions

The existing battalion and the regiment will probably be eliminated this summer when the Army's infantry divisions are repackaged.

The division would fight with three "combat commands." Under each command would be "battle groups," slightly larger than present battalions. Squads would be larger.

The new division should be more capable of either atomic or conventional warfare.

The reorganized division would not be much smaller than the 17,200-man strength of the present infantry division, but its more and smaller elements would have greater mobility and balance.

The armored division, now numbering 14,500 men, might be smaller but not significantly so.

Paper Blizzard

Government paper work now costs taxpayers about four billion dollars a year.

The Hoover Commission proposed an economy program against "red tape in Government" that could save initially about $255,000,000 annually.

The Commission reported that the "enormous volume of paper work imposed upon top Federal executives interfered with their basic responsibilities."

It declared that the Government generally had made "little progress" in reducing this paper work.

As a possible way out of the paper blizzard, the Commission urged President Eisenhower to establish by Executive Order a Governmentwide "paper work management program" and to direct his top officials to support it.

The Commission recommended that the General Services Administration supervise all paper work management in the Executive Branch. The purpose would be to simplify and improve the quality of forms, letters, and reports. It was felt that the cost of producing, issuing, and storing this material could be reduced.

The Hoover group proposed that some top official in each agency be assigned to simplify all Government forms and to eliminate nonessential reports and unnecessary copies of letters. This official would coöperate with the G.S.A. The latter is the Government's housekeeping agency created by Congress on the recommendation of the first Hoover Commission.

Immediate savings could be realized, the Commission said, if the employers' quarterly Federal tax returns were eliminated. These forms now require from employers some 180,000,000 lines of information on employees and their earnings.

The Commission made the following observations on red tape and gobbledegook:

The Government created and handled at least 25 billion pieces of paper each year, not counting tons of technical manuals and pamphlets. There were more than 750,000 full-time paper workers. Office space for these workers was equal to 36 Empire State Buildings. The space had an annual rental value of $180,000,000.

Space for 24,000,000 cubic feet of Federal records was enough to fill seven Pentagons and cost more than $40,000,000 a year.

More than one billion individual letters were turned out in Federal offices each year at a cost of approximately one billion dollars.

The cost of all this paper boondoggling, including split infinitives and dangling clauses, is about $100 a year in taxes to the average American family of four.

Fission Weapons For Peace

An Editorial

THE Atomic Energy Act of 1954 states that the "development, use, and control of atomic energy shall be directed so as to promote world peace, improve the general welfare, increase the standard of living, and strengthen free competition in private enterprise."

The AEC Act of 1954 represents the first complete revision of the statutory charter of the Commission since passage of the original legislation in 1946.

The paramount objective of the AEC was not altered. It was, and is, to make the maximum contribution to the common defense and security. The only significant modification has been the added emphasis given to the development of the peacetime uses of atomic energy.

Workable authority was provided to permit greater international coöperation; to increase the participation by private enterprise; and to assure effective dissemination of both scientific and industrial information. The latest public report of the Committee is thus timely and revealing.

"Operation Castle," conducted in the spring of 1954 at the Pacific Proving Ground, was the most extensive test series yet held. It contributed greatly to further progress in the design, development, and proof test of weapons.

OUR weapons program today is being directed toward new areas of research, opened up by Operation Castle, that hold rich promise of additional major developments and the additional stockpiling of weapons that will increase our defensive peacetime strength.

A series of nuclear tests, according to the Commission report, were also held at the Nevada Test Site to obtain scientific knowledge essential to the development and utilization of nuclear weapons for peace. Civil Defense and the Public Health Service participated in the tests for the purpose of personnel training through observation and field exercises. Special attention was given to the limitations and procedures required to assure public safety.

An unusual record of on-site and off-site safety was achieved in the operation of the Nevada tests. A low level of public exposure was achieved through close attention to a variety of controls and procedures. Additional improvements are contemplated to provide increased assurance of public safety and to reduce the possibility of undesirable off-site public exposure.

These key improvements will include improved methods of forecasting wind speed and direction, improved methods of predicting fall-out intensity and location, reducing fall-out by such means as yield limitations under various conditions, and intensified off-site radiological safety operations.

President Eisenhower last year cited the Los Alamos Scientific Laboratory for invaluable service to the Nation. In expressing the gratitude of the people of the United States, President Eisenhower declared that "the Laboratory's momentous success in the field of fission weapons has been followed by equal accomplishments in the fusion field. These achievements are the result of a remarkable group endeavor and the devoted and skillful effort of the individuals of the staff of the Laboratory."

THE Atomic Energy Commission's two other principal laboratories in the weapons program, Sandia Corporation and the University of California Radiation Laboratory, are also contributing noteworthy accomplishments. Sandia Corporation is primarily concerned with the development and design of the nonnuclear phases of atomic weapons. The major efforts of the UCRL weapons research laboratory at Livermore, Calif., are directed toward the research, development, and testing of nuclear systems. Both laboratories, as well as the Los Alamos Scientific Laboratory, played major rôles in this year's test series.

President Eisenhower's "atoms for peace" program is moving forward rapidly. The Atomic Energy Commission, according to Chairman Lewis L. Strauss, has allocated a substantial amount of fissionable material for this purpose.

"We are negotiating with a number of governments pursuant to the terms of the new law," Admiral Strauss said, "in order to make it possible for them to participate in the program."

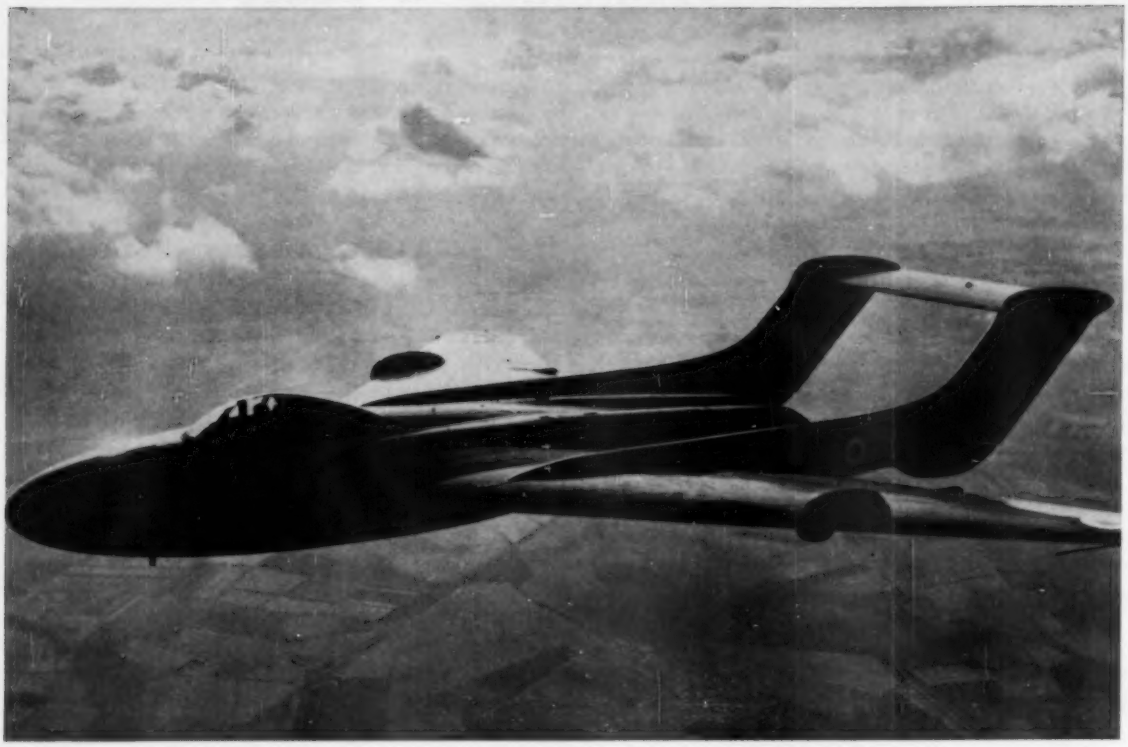
The AEC's budget is leveling off at about two billion dollars annually. Although one billion dollars will be devoted to the manufacture of nuclear weapons, almost half a billion will be spent, in the next three years, to develop atomic power plants and engines.

Extensive progress has been made in the field of reactor development. Ground has been broken for the Nation's first full-scale civilian atomic power plant. Our first atomic submarine has successfully concluded its sea trials. Industry is taking an increasingly active interest in the field by investing private funds in the study of the peaceful applications of atomic energy.

Several firms have shown an intense interest in the AEC's Power Demonstration Reactor Program under which AEC will consider bearing a portion of the expense of reactor plants "leading to the demonstration of the practical value of such facilities for industrial or commercial purposes." Each proposal from industry to build and operate power demonstration reactors under this program will be evaluated on the basis of its contribution toward the development of economically competitive nuclear power.

The Atomic Energy Commission is doing an excellent job in directing a great variety of research projects in a great many fields—agricultural, medical, and industrial. It is demonstrating the practical value of using atomic production facilities for industrial and commercial purposes. It is opening up the area of patentability of inventions or discoveries other than those in the field of the military utilization of nuclear energy.

Recent British Aircraft



Powered by two Rolls Royce jet engines and armed with 30-mm. Aden guns, the De Havilland 110 twin-boom supersonic fighter, above, is one of the "hottest" aircraft in the Royal Navy. The Hawker Hunter jet fighters, below, now with the Royal Air Force, have been clocked at over 726 m.p.h. Each carries four Aden guns and automatic range-finding radar (British photos).

ASSOCIATION AFFAIRS

National Executive Committee Holds Spring Meeting in Washington, D. C.

The Executive Committee of the Association's Board of Directors held its spring meeting at Association headquarters, Washington, D. C., on Thursday, March 3, 1955. This was the first occasion at which Vice Adm. George F. Hussey, Jr., the recently elected president, presided.

Also present were Louis Polk, Dayton; Robert L. Biggers, Detroit; Harvey C. Knowles, Cincinnati; Lieut. Gen. Levin H. Campbell, Jr., Washington; and Col. Henry N. Marsh, Washington, directors.

Also present were John H. Floberg, assistant counsel; Maj. Gen. James D. McIntyre, treasurer; Col. Leo A. Codd, executive vice-president; and Florence G. Ferriter, secretary.

After greeting the members, Admiral Hussey directed the reading of a resolution memorializing Maj. C. Stewart Comeaux, late a director of the Association, which was adopted. Colonel Codd presented the annual report on 1954 operations, General McIntyre explained the financial status, and General Vincent described the status of some recently organized Technical Divisions.

Items of special interest approved by the Committee under new business were the budget of expenditures and receipts for 1955; plans for the Thirty-seventh Annual Meeting in San Francisco on May 10-11, 1955; plans for the Industrial Preparedness Dinner Meeting, December 7, 1955; the organization of a press relations panel for improving public information about the A.O.A.; and a plan to conduct a series of seminars on industrial preparedness and defense mobilization under the sponsorship of various A.O.A. Posts.

The committee unanimously approved the appointment of John S. Pfeil, a regional vice-president, to fill the unexpired term of Major Comeaux until December 31, 1955.

The meeting adjourned to the Carlton Room of the Sheraton-Carlton Hotel for a luncheon in honor of Brig. Gen. Burton O. Lewis who is retiring as A.O.A. staff consultant for Technical Divisions and Committees.

After welcoming the luncheon guests, Admiral Hussey, the presiding officer, turned the proceedings over to Mr. Polk who presented General Lewis with a leatherbound portfolio of letters of felicitation from his many friends throughout industry and the services. General Campbell, past national president of the A.O.A., read the citation for the Brig. Gen. John H. Rice Gold Medal which was bestowed on General Lewis by the Association for his outstanding work for the national defense. Mr. Knowles, national vice-president, made the presentation. This was a most appropriate honor as General Lewis served under General Rice in the early part of his career in Army Ordnance.

Andy Langhammer, chairman of the Powder Metallurgy Committee, and Brig. Gen. J. B. Medaris, chief, Industrial Division, Office of the Chief of Ordnance, presented General Lewis with a plaque depicting a social get-together of the Powder Metallurgy Committee.

General Lewis replied to the good wishes he received in an address in which he reminisced over some of his early experiences and heartily thanked all his friends for their support and assistance during his eight years as consultant for the Technical Divisions and Committees.

An assemblage of over eighty distinguished officers and Government officials was on hand to honor General Lewis. At the speakers' table were: Hon. George H. Roderick, Assistant Secretary of the Army; Mr. Polk, president, Sheffield Corporation; General Medaris; Mr. Knowles, vice-president, Procter & Gamble Company; Maj. Gen. E. L. Cummings, Chief of Army Ordnance; Hon. Donald A. Quarles, Assistant Secretary of Defense; Admiral Hussey, managing director, American Standards Association; General Campbell, chairman, Automotive Safety Foundation; Maj. Gen. C. M. Wesson, a retired Chief of Ordnance; Hon. Frank H. Higgins, Assistant Secretary of the Army; Brig. Gen. Edward P. Mechling, commander, Air Force Armament Center, Air Research and Development Command; and Mr. Biggers, president, Fargo Division, Chrysler Corp.

BIRMINGHAM POST HEARS GENERAL MEDARIS

The Birmingham Country Club was the scene of a gala dinner meeting on March 15th when the members of the Post welcomed the chiefs of the Ordnance districts and their deputies and arsenal commanders who had assembled in Birmingham from all parts of the country to discuss their problems with the Chief of Army Ordnance, Maj. Gen. E. L. Cummings.

Claude S. Lawson, vice-president of

Among those present at the Executive Committee luncheon were, left to right: Maj. Gen. E. L. Cummings; Hon. Donald A. Quarles; Brig. Gen. Burton O. Lewis, guest of honor; Vice Adm. George F. Hussey, Jr.; and Lieut. Gen. Levin H. Campbell, Jr.

the Post, acting for Warren Whitney the president, introduced the distinguished guests. Col. Leo A. Codd, executive vice-president of the A.O.A., outlined the high points of the Association's annual report and briefed the audience on the program for the annual meeting at San Francisco in May.

Brig. Gen. J. B. Medaris, chief, Industrial Division, Office of the Chief of Army Ordnance, the principal speaker, addressed the gathering of over 300 members and guests on the subject of the layaway plan. He presented an up-to-the-minute picture of results achieved and described plans for future operations that would ensure prompt resumption of defense production in an emergency.

• **AT SAN FRANCISCO.**—A meeting of the board of directors of the San Francisco Post was called on March 11th by Post President Lawrence S. Fletcher to discuss arrangements for the Thirty-seventh Annual Meeting of the American Ordnance Association to be held on May 10 and 11, 1955. At the luncheon meeting, held at the Stock Exchange Club, the board heard Capt. J. M. P. Wright from national headquarters outline the 2-day program and approved the membership of the various committees of Bay Area citizens and Ordnance stalwarts who will assist at the meeting.

TRI-CITIES CHAPTER HAS RECORD TURNOUT

The Tri-Cities Chapter of the Empire Post enjoyed a record turnout for its annual meeting at the Vestal American Legion Hall, Binghamton, N. Y., on March 10th. This was a double ceremony to greet Brig. Gen. T. K. Vincent, formerly commanding Redstone Arsenal and now on the A.O.A. staff in Washington, D. C., and to applaud "Mike" Lawlor, the retiring Chapter chairman who in the past year has brought the Chapter back to life through his ceaseless, energetic, and genial efforts.

More than seventy-five members and guests were on hand for the dinner which was followed immediately by the presentation of a certificate of appreciation from national headquarters and a special A.O.A. plaque from the local members to Mr. Lawlor.

Following the dinner a 20-minute film was shown on the assembly, launching, and flight of the German V-2 missile. General Vincent then gave an informal but extremely interesting account of his problems and experiences in the design and development of missiles.

Albuquerque Chapter, Rocky Mountain Post, Doubles Membership in 3 Months

The Albuquerque Chapter of the Rocky Mountain Post held its monthly meeting at Mitchell Hall, University of New Mexico, on March 10th. The newly elected chairman, Col. Charles F. H. Begg, presided and introduced Rear Adm. W. W. Juvenal, of the AEC Santa Fe operations office, who welcomed the members and guests and described the aims of the meeting committee.

Rear Adm. A. E. Uehlinger, U.S.N., Ret., formerly in command of the Navy rocket and guided-missile activity at White Sands Proving Ground, presented a film describing the Navy's Viking research rocket and the data it brings down from the upper atmosphere.

In addition to quarterly meetings for all members, this alert newly formed Chapter holds monthly luncheon meetings of its officers to plan continuously new and worth-while activities and programs. In three months the membership has more than doubled.

Col. Charles F. H. Begg, Chapter chairman, center, admires A.O.A. plaque while Rear Adm. W. W. Juvenal, meeting chairman, left; R. F. Hansen, vice-chairman; Richard Watkins, membership chairman; Rear Adm. A. E. Uehlinger; and L. E. Snodgrass, secretary-treasurer of the Chapter, right, look on.

General Pate and General Medaris Address Meetings of Washington Post

The Washington Post continued its program to keep abreast of world affairs at its monthly luncheon meetings on February 17th and March 24th at the National Press Club.

The February 17th meeting was a gala affair in honor of Lieut. Gen. R. McC. Pate, Assistant Commandant and Chief of Staff of the Marine Corps. George M. Riveire, Post president and presiding officer, introduced the following distinguished guests at the speakers' table:

Capt. C. E. Briner, U.S.N., Navy Bureau of Ordnance; Brig. Gen. F. H. Wirzig, Director of Information, U. S. Marine Corps; Brig. Gen. James P. Newberry, U.S.A.F., Assistant for Logistic Plans, Office, Deputy Chief of Staff, Material; Karl Ammerman, vice-president, Washington Post, A.O.A.; Brig. Gen. T. A. Wornham, G-3, U. S. Marine Corps; Brig. Gen. Samuel S. Jack, Deputy Director, Marine Aviation Division, Office, Chief of Naval Operations.

General Pate, a veteran of more than thirty years' service who fought in many actions in World War II, treated the audience to a concise outline of the manner in which the Marine Corps will continue to meet its worldwide commitments in spite of manpower reductions. He said the Marines will actually expand their fighting effectiveness by increased use of helicopter lift and greater firepower per unit.

Brig. Gen. J. B. Medaris, chief of the Industrial Division, Office of the Chief of Ordnance, was the guest of honor and principal speaker on March 24th. A record audience of over 200 members and guests was on hand to welcome the general.

Among the distinguished guests introduced by Post President George M. Riveire were Assistant Secretary of the Army Frank H. Higgins; Rear Adm. F. S. Withington, Chief of the Navy Bureau of Ordnance, and his deputy, Rear Adm.

P. D. Stroop; Maj. Gen. J. H. Hinrichs, chief of the Field Service Division, Office of the Chief of Army Ordnance; Rear Adm. N. K. Dietrich, deputy commander, Military Sea Transportation Service; Maj. Gen. R. A. Anderson, Quartermaster General of the United States Marine Corps.

General Medaris delivered a splendid address in which he pointed out the vital importance of industrial preparedness in view of the many uncertainties of the trend in national affairs and the probability that this Nation will not have much time to prepare in future wars.

He explained that the industrial-preparedness plans of Army Ordnance depend on the maintenance of a dynamic industrial base. These plans are kept flexible to meet all eventualities with emphasis on capability to produce rather than large stocks on hand. General Medaris stated that many successes have been achieved in the stand-by program and although much remains to be accomplished we can expect great progress in view of the strong support Army Ordnance is receiving from United States industry.

STUDENT A.O.A. CHAPTER INAUGURATED AT RUTGERS

The Rutgers University Student Chapter of the New York Post was inaugurated in an impressive ceremony on February 15th in the university gymnasium, New Brunswick, N. J.

After luncheon at the Student Union the distinguished guests assembled in the gymnasium where Maj. Gen. Russell L. Maxwell, president of the New York Post, presented the charter to Cadet Maj. L. E. Enderle, R.O.T.C., president of the new Chapter.

The C. Stewart Comeaux Trophy established by the New York Post as a memorial to the late Major Comeaux, formerly a director of the Association, was presented to Rutgers University by Vice Adm. George F. Hussey, Jr., president of the American Ordnance Association.

The trophy is for competition by R.O.T.C. students at Rutgers in accordance with rules to be promulgated by university authorities. Dr. Lewis Webster Jones, president of Rutgers, accepted custody of the trophy in an address that outlined the essential need for a strong R.O.T.C. and expressed his thanks for the interest of the Association in R.O.T.C. affairs.

Dr. Lewis W. Jones accepts the Comeaux Trophy from Vice Adm. G. F. Hussey, Jr.

AN ORDNANCEMAN'S PRAYER

Rev. Austin L. Healy
Lieutenant Colonel, Air Force Reserve (Inactive)
Pastor, St. Joseph's Catholic Church, Sykesville, Md.

Lord God, Father of the learned and the unlearned, the big and the little, the full and the empty, with filial simplicity we bow thankfully before you for our countless blessings, particularly for your generosity in letting us share so abundantly in your almighty power and your infinite knowledge.

We hasten to ask you to temper with your spirit of charity the awesome powers you have entrusted to our hands and to direct with your wisdom the august knowledge you have entrusted to our minds.

Teach, especially the leaders in Ordnance, to use their tremendous share of power and knowledge to reconstruct the proper order of father and child between creature and Creator and to reëstablish the tranquil order of brother and brother amongst fellow creatures. This we pray from your bounty, through Christ our Lord, Amen.
—Delivered at meeting of the Aberdeen Post, A.O.A., Sheraton-Belvedere Hotel, Baltimore, Md., January 27, 1955.

Brig. Gen. John F. R. Seitz, commanding general, Camp Kilmer, concluded the ceremony with a brief talk on the importance to national defense of a large and active Reserve force.

FLORIDA POST MEETS AT EGLIN AFB

The Florida Post held its monthly dinner meeting at the old Service Club at Eglin Air Force Base on February 7th.

Post President Col. Paul S. Bechtel introduced the guest of honor and principal speaker, Lieut. George Webb, U.S.N., from the Naval Air Station Ground Training Department, Pensacola, Fla.

Lieutenant Webb, who has had over fifteen years' experience in carrier operations as an aviation machinist and later as a pilot, gave a very fine presentation on naval aviation history. His talk included a film on naval carrier operations during the past thirty years. This movie was very enlightening, covering the many problems encountered by the Navy in the development of carrier aircraft, ships, and flight operations.

• **AT MOLINE.**—All members of the Quad Cities-Iowa Post were invited to a meeting of the Reserve Officers' Association on the evening of February 22, 1955, to hear Rear Adm. E. T. Layton, Joint Staff of the Joint Chiefs of Staff, Washington, D. C., speak on "The Rôle of Our Navy in Future Wars."

A.O.A. members were gratified to witness the presentation of an award to P. S. Mumford, president of the A.O.A. Quad Cities-Iowa Post, for participation in National Defense Week activities by his Post. Brig. Gen. T. A. Weyher, chief of the Ordnance Weapons Command, Rock Island Arsenal, Ill., also received an award for his continued efforts to further close relations between the active-duty and Reserve personnel of the armed forces in his area.

Inside Story of the FN Light Rifle Told to Members of the Yankee Post

The Yankee Post held its midwinter meeting on Tuesday, February 1, 1955, at the Hotel Somerset, Boston.

After dinner the presiding officer, Post President Charles B. Weeks, Hesse-Eastern Corporation, greeted the members and guests and introduced Col. Roland B. Anderson, deputy chief of the Boston Ordnance District, who, with Lester F. Mulno of Harrington & Richardson, Inc., presented the inside story of the FN rifle. Colonel Anderson gave an early picture of the design and acceptance of the rifle by NATO.

He was followed by Mr. Mulno who described how Harrington & Richardson under Army Ordnance was redesigning the FN rifle to fit American mass-production techniques. He explained that a limited number of test models would be

manufactured for evaluation in competition with a modified M1 Garand.

This presentation was followed by a sound film in color showing the new techniques in manufacturing bomb bodies from seamless tubing developed by the Walsh Construction Company, Portland, Me. The evening was concluded with a brief review by Colonel Anderson on the current status of ordnance procurement and the prospects for future allocations to New England.

Aberdeen Proving Ground Post Has Successful Meeting in Baltimore

The Aberdeen Proving Ground personnel and the executives and engineers of Baltimore industry who comprise the membership of the Aberdeen Post assembled for a dinner meeting on January 27, 1955, at the Sheraton-Belvedere Hotel in Baltimore. This, the first meeting held in Baltimore by the Aberdeen Post, was a tremendous success.

H. D. Duppstadt, Automotive Division, Aberdeen Proving Ground, and Post president, greeted the guests and introduced Walter F. Perkins, vice-president and general manager of the Koppers Company. This popular citizen of Baltimore first presented the mayor of the city, the Hon. Thomas D'Alesandro, Jr., who welcomed the members and guests, and expressed his appreciation for the Association's strong support of our national defense.

The mayor was followed by Col. Leo A. Codd, executive vice-president, A.O.A., who spoke in praise of the outstanding interest shown by the Aberdeen Post members and reviewed the aims of the A.O.A.

The guest of honor, the Hon. William H. Martin, Deputy Assistant Secretary of Defense for Applications Engineering, formerly a vice-president of Bell Telephone Laboratories, Inc., spoke on a topic of vital interest to all industrialists present. He differentiated between exploratory development of military weapons and equipment by scientists and Reserve engineers and the second phase of development where the equipment developed leads directly to a producible design.

Mr. Martin then observed, to the great interest of the industrialists present, that the ideal in ensuring an effective and reliable product was to have the prime contractors for the development also assume the contract for the first production lot which should include test equipment, tools, and technical assistance to the using service.

He stressed particularly the need for greater improvements in reliability of equipment especially its electronic components, and noted that in the average 5-year life of an electronic component maintenance costs are ten times the initial cost of the item.

Among other distinguished guests at the speakers' table were: R. S. Boutelle, Fairchild Engine and Aircraft Corporation, Army Chemical Center; Brig. Gen. J. W. Burns, commanding general, Army Chemical Center; W. B. Bergen, Glenn L. Martin Company; Thomas F. Colleran, Aberdeen Proving Ground; George H. French, Maryland Dry Dock Company; Frank W. Godsey, Jr., Westinghouse Electric Corporation; Brig. Gen. J. Horridge, Aberdeen Proving Ground; Capt. H. W. Howe, Naval Training Center; Brig. Gen. J. B. Medaris, Office, Chief of Ordnance; Adam J. Quick, Black & Decker Manufacturing Corporation; Maj. Gen. John W. Sessums, Jr., vice commander, Air Research and Development Center.

Hon. William H. Martin, Deputy Assistant Secretary of Defense, left; Brig. Gen. J. B. Medaris, Office, Chief of Army Ordnance, center; and Thomas F. Colleran, Aberdeen Proving Ground, right, chat at meeting of Aberdeen Proving Ground Post.

SYRACUSE CHAPTER HONORS RESERVES

The Syracuse Chapter of the Empire Post held its midwinter meeting in honor of the Reserves of the armed forces at the Hotel Onondaga on February 23rd. The guest of honor was Rear Adm. Wilson D. Leggett, Jr., Chief of the Navy Bureau of Ships.

The dinner meeting was called to order by Chapter Chairman Paul L. Christensen who introduced the following distinguished guests who spoke briefly on behalf of their organizations in greeting the more than 300 members and guests who attended:

Col. Preston E. James, president, Onondaga County Chapter, Reserve Officers' Association; Col. Edward G. Miller, deputy chief, Rochester Ordnance District; Col. Daniel T. Foley, U.S.A.F., Rochester Procurement Office; Comdr. A. W. Czehatowski, inspector of naval material, Syracuse.

The guest of honor was introduced by Comdr. Richard H. Amberg, U.S.N.R., publisher of the Syracuse *Post-Standard*. Admiral Leggett responded and delivered a talk that covered the recent and prospective growth of the Navy both in ships and their armaments.

• **AT PHILADELPHIA.**—The board of directors of the Philiadelphia Post met on January 26, 1955, at the Union League Club, Philadelphia, for luncheon and a discussion of future plans.

The meeting was called by Post President W. H. Worrilow, Sr., to discuss a spring meeting to be held aboard an excursion steamer on the Delaware River. Whereas last June the Post steamed north to visit the Fairless plant, it was planned this year to go down the river, visiting plants in the Chester area on a day's outing to include luncheon, a business meeting, and commentary on the industries that line the banks of the Delaware. A committee was established to work out the details for the meeting.

Before adjournment, another committee was proposed for outlining an active public-information program to insure that the aims and ideals of the A.O.A. are made known to the citizens of the Philadelphia area.

Among those who enjoyed the Capital Cities Post meeting were, seated left to right: Vice Adm. W. A. Kitts, 3rd, Brig. Gen. D. R. Ostrander, and Col. E. S. Mathews; standing, left to right: John Wyld, D. R. Rogers, and Earl D. Rhodes.

General Ostrander Is Guest of Honor At Meeting of the Capital Cities Post

The Capital Cities Post held its winter meeting at the Edison Club, Rexford, N. Y., on February 7th.

Over 150 members were on hand to greet Brig. Gen. Don R. Ostrander, director of development of the Air Research and Development Command, Baltimore, the guest of honor. Earl D. Rhodes, Post president and vice-president of F. C. Huyck & Sons, presided and introduced the distinguished guests and Post officers including Vice. Adm. W. A. Kitts, 3rd; Col. E. S. Mathews, commanding officer, Watervliet Arsenal; John Wyld, regional manager, New York State Department of Commerce; and D. R. Rogers, civilian aide to General Ostrander.

General Ostrander stressed the importance of quality in today's weapons and outlined the manner in which the Air Research and Development Command was working to ensure this goal.

At a committee meeting before the dinner the following members were elected to the board of directors: Admiral Kitts, Edward S. Webster, Prof. A. A. K. Booth, and E. Merritt Ashworth.

• **GEN. BREHON B. SOMERVELL,** president of Koppers Company, Pittsburgh, and a director of the Pittsburgh Post, American Ordnance Association, died at his home in Ocala, Fla., February 13, 1955. He retired from active Army service in 1946, having served as Commanding General of the Army Service Forces from 1942.

General Somervell was born in Little Rock, Ark., and was graduated from the United States Military Academy at West Point in 1910. In 1936 he was appointed Works Progress Administrator for New York and in 1940 was assigned to Washington to direct the construction activities of the Corps of Engineers. The Pentagon headquarters of the Defense Establishment in the Nation's Capital was designed and built under his direction.

After nearly three years of most successful operations toward munitionment by the supply branches, the Army was reorganized in the spring of 1942 when the Army Service Forces were established under General Somervell's direction. The vast logistics operations involved in the supply of equipment to two major fighting zones—thousands of miles distant from the United States and in each case across vast oceans—required a method of shipment, storage, and availability in unheard-of quantities. General Somervell met this task on these fronts with outstanding success.

General Somervell was active in the affairs of the Pittsburgh Post of the Ordnance Association where many of his contemporaries, both military and civilian, were among his close associates.

• **COL. CALVIN H. GODDARD,** one of America's outstanding authorities on small arms and a contributing editor to this magazine for more than a quarter of a century, died at his home in Washington, D. C., on February 22, 1955. Noted also as a military historian and criminologist, he was military editor of the Encyclopaedia Britannica.

A native of Baltimore, Md., Colonel Goddard was graduated from the Johns Hopkins University Medical School. Having entered the Army in 1915 he returned to civilian life at the end of the First World War when he founded and developed the science of forensic ballistics which became a full-time pursuit. He established a scientific crime detection laboratory at Northwestern University in 1929.

In the intervening years his fame as an expert in this field of research and application became worldwide, and he was called upon to assist in many criminal proceedings throughout the country.

In 1935 he received a Guggenheim Foundation fellowship for the further study of arms identification under which he traveled in Europe, studying the methods and products of European producers.

Throughout the period between the two World Wars, Colonel Goddard was an active and enthusiastic member of the Army Ordnance Reserve Corps. Indeed, during the 1920's and 1930's when training funds were not available, he frequently undertook training at arsenals and depots, bearing all the expenses himself.

Upon the outbreak of the Second World War he was called to active duty to head

Col. Calvin H. Goddard

the historical section of the Ordnance Department of the Army. His work here was of the thorough and comprehensive character for which all his endeavors were noted. Later he served in Japan where he was in charge of the Army's criminal investigation work. Three years ago he returned to the United States to organize and direct the preparation of the Army's 40-volume medical history of World War II.

His profound knowledge of armament, and especially of small arms, his meticulous analysis of facts, and his fascinating style of writing have been well known to the readers of ORDNANCE for many years.

Cal Goddard leaves an enviable record of achievement and an array of his handiwork as a fitting memorial to his outstanding ability and devoted patriotism.

• **LUTHER S. OAKES,** founder and first president of the Northwest Post of the American Ordnance Association, died at Minneapolis, Minn., on February 25, 1955. He was prominent in the construction industry, being chairman of the board and former president of Winston Brothers Company, one of the Nation's leading general construction organizations.

Mr. Oakes was a native of Vermont. After graduation from Dartmouth College he took up his residence in Minnesota. He joined the Winston Brothers firm in 1907, becoming its president in 1921. In this capacity he directed the operations of the company in the Mesabi and Cuyuna iron-ore ranges as well as in South America and Canada.

First president of the Northwest Post of the Ordnance Association in 1945, Mr. Oakes was a director of the Post at the time of his death. He served as a member of the Association's Council, continuing his interest in armament preparedness begun in the Second World War when his company was active in the construction of new ordnance plants.

• **WILLIAM R. ELLIS,** long a member of the American Ordnance Association and former past president and director of Hercules Powder Company, Wilmington, Del., died at San Francisco on January 30, 1955. He had retired from active business last year and returned to his native California.

Mr. Ellis, a graduate of Stanford University, worked in Western gold and copper mines before joining the Hercules organization thirty-nine years ago. He was in great measure responsible for the organization and direction of the company's program for the production of powder and explosives during the Second World War.

He directed the operations of six Government-owned powder and explosives plants which were operated by the company for the Ordnance Department of the Army. One of these operations was the manufacture of all bazooka and other rocket-propellent powder used by our armed forces.

Genial, capable, and deeply patriotic, Mr. Ellis served his country and industry in an outstanding manner which contributed greatly to the security and progress of both.

• **COL. EDWIN M. CHANCE,** a charter member of the American Ordnance Association and one of the founders of the Philadelphia Post, died on November 26, 1954. He served with distinction in the Ordnance Department of the Army during the First World War. He was president of United Engineers and Constructors, Inc., of Philadelphia.

Colonel Chance was born at Philadelphia in 1885 and received his bachelor of science degree in chemistry from the University of Pennsylvania in 1907. He served in the Ordnance Department of the Army and later in the Chemical Warfare Service in the First World War. He was in charge of the design, construction, and operation of the chemical shell filling plant at Edgewood Arsenal in 1917 and served with the American Expeditionary Forces in 1918.

Colonel Chance was among that small group of American citizens who, following the First World War, realized the great need for a national society devoted to armament preparedness, and he gave unstintingly of his time and effort to the formation of the then Army Ordnance Association in 1919 and the founding of the Philadelphia Post of the organization in 1926.

Divisions and Committees

Henry N. Marsh, Ordnance Stalwart, Now Deputy Assistant Secretary of the Army

Assistant Secretary of the Army Frank H. Higgins on March 29th appointed Henry N. Marsh, of Wilmington, Del., as Deputy Assistant Secretary of the Army (Logistics and Research and Development).

Since 1952, Colonel Marsh has served as smokeless-powder consultant to the explosives department of Hercules Powder Company and as adviser on civilian and military matters. Colonel Marsh has been granted a year's leave of absence by Hercules to accept this appointment.

Henry N. Marsh

Colonel Marsh has been responsible for Hercules' development and production for the armed forces of rocket propellants, which started with the bazooka and in recent years resulted in booster and propellent charges for guided missiles such as the Nike and for the Honest John artillery rocket.

As chairman of the American Ordnance Association's Technical Divisions and Committees, he has served as ordnance consultant to the armed services.

Since 1952, Colonel Marsh has frequently traveled to Europe as adviser to the Offshore Procurement Organization and as coördinator and consultant on the facilities assistance programs for 1954 and 1955. In this capacity he has served as consultant to the Assistant Secretary of Defense (International Security Affairs) and to the Deputy Chief of Staff for Logistics, United States Army, in the field of foreign aid.

At the outbreak of World War II, Hercules Powder Company was called upon by the War Department to design, build, and place in operation the Radford Arsenal, Radford, Va. This was followed by similar contracts for the New River Ordnance plant, adjacent to Radford; the Badger Ordnance Works at Baraboo, Wis.; and the Sunflower Ordnance Works at Lawrence, Kans. Colonel Marsh was in a supervisory capacity for all these projects.

From September 1 to December 30, 1950, Colonel Marsh was consultant to the Secretary of Defense and assigned to the Military Production and Supply Board of the North Atlantic Treaty Organization on a survey of capacity for production of explosives, propellants, and artillery ammunition in the NATO countries. In 1951, he returned to Hercules Powder Company to handle U. S. Government business.

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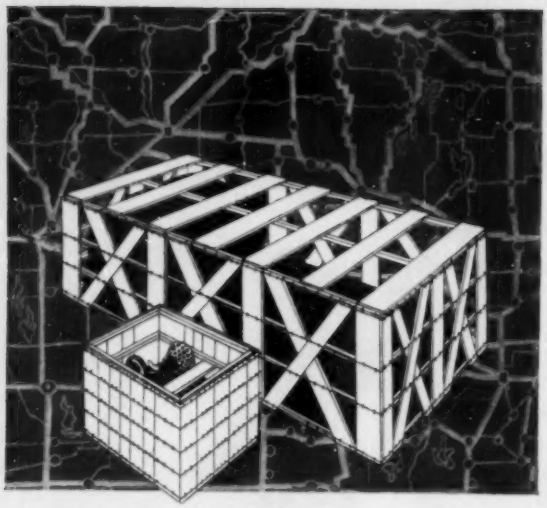

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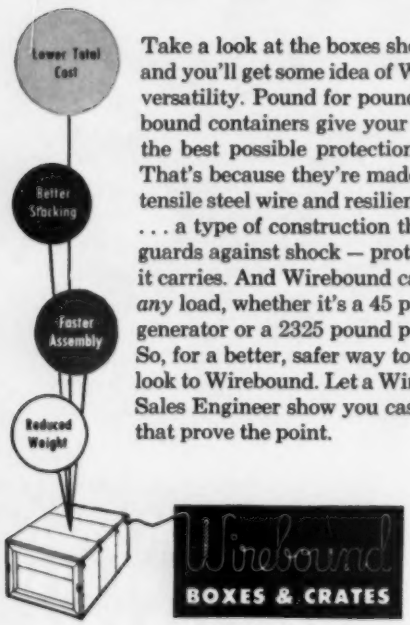

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Development and Materials Committee Meets at Redstone

The Development and Materials Committee of the Guided Missile, Rocket and Jato Division of the A.O.A. met at Redstone Arsenal, Huntsville, Ala., on February 15, 1955, under the chairmanship of Howard L. Miller. The program of this meeting was a continuation of that held in January at the Allegany Ballistics Laboratory.

This Committee is engaged in a classified study which will furnish the defense services with a long-needed and valuable report, eliminating the existing confusion in the area of metal plates, sheets, and tubing used in the rocket and jato field.

The coöperation, planning, and hospitality extended by the Redstone Arsenal commanding general, Brig. Gen. H. N. Toftoy, and by Joseph Rush, director of the Rocket Development Division of the Ordnance Missile Laboratories, and their staffs was greatly appreciated and was the subject of much favorable comment by those attending. Additional meetings will be held until the study is completed.

Surface Preservation Group Hears Papers at Los Angeles

The Surface Preservation Committee of the Advisory Technical and Research Group met at the Ambassador Hotel in Los Angeles on February 8-9, 1955, under the chairmanship of Dr. G. W. Seagren. A very comprehensive program of technical papers included the following:

"Over-all Surface Preservation Program and Its Coördination between the Various Military Services," by C. R. Cornthwaite, Office, Chief of Army Ordnance.

"Proposed Manual on Finishing of Rockets and Shells," by H. E. Spitzer, Sherwin-Williams Company.

"Sintered Iron Rotating Bands," by Dr. P. J. Rich, Kwikset Locks, Inc., and A. J. Tuckerman, Frankford Arsenal.

"Protection of Interior Cavity Threads of Projectiles," by Harold Davidson, Navy Bureau of Ordnance.

"Steel Shell Cases," by A. J. Tuckerman, Frankford Arsenal.

"Electroplating Problems," by M. B. Diggin, Hanson-Van Winkle-Munning Company, and Lloyd Gilbert, Rock Island Arsenal.

"Paint Specifications," by Dr. C. F. Pickett, Aberdeen Proving Ground.

"Phosphate Coating Specifications," by Lloyd Gilbert, Rock Island Arsenal.

Plant visits were scheduled to Norris Stamping Company, Harvey Machine Company, West Coast Loading Company, Clary Multiplier Corporation, and Hunter Douglas Company.

The Committee feels that it was beneficial to industry and the services alike to have been able to meet in the far West. This great industrial center calls for more Association participation in the Los Angeles area.

The hospitality extended by the Los Angeles Post of the A.O.A. and the planning by the official host, Dr. Rich, made this meeting one of the best.

Underwater Ordnance Division Established by Association

The Underwater Ordnance Division, established by the Executive Committee of the Association in September 1954, has been organized and is functioning. This Division is different in that its activities are related solely to one of the defense services—the Department of the Navy. (*Continued on p. 920*)

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Vice Adm. W. W. Kitts, 3rd, U.S.N., Ret., who organized the Underwater Ordnance Division and was its first chairman, resigned on March 31, 1955, due to a change in his activities with the General Electric Company. The deputy chairman, Adm. A. G. Noble, U.S.N., Ret., assumed the chairmanship of the Division on April 1, 1955.

Admiral Kitts was born in Oswego, N. Y., on April 14, 1894, was appointed to the United States Naval Academy in 1912, and was graduated in 1916. Later he attended the Massachusetts Institute of Technology, from which he also holds a degree, and the Postgraduate School, United States Navy, at Annapolis, where he majored in ordnance engineering.

After a long and distinguished career in the Navy, serving at sea in combat areas, in shore stations, as Assistant Chief of the Navy Bureau of Ordnance, and with industry, he retired on June 30, 1951. During his active service he was decorated with the Navy Cross, the Legion of Merit with two gold stars, the Purple Heart, Order of Commander of the British Empire, and the Chinese Cloud and Banner Medal.

Admiral Kitts

Admiral Kitts has been associated with the General Electric Company Apparatus Sales Division, since his retirement, as manager of ordnance engineering. He has recently been named manager of General Electric's newly created Industrial Atomic Products Study for the General Electric Atomic Products Division, Schenectady, N. Y.

Admiral Noble was born in Preston, Tex., December 14, 1895, and was appointed to the Naval Academy in 1913. He graduated with credit in 1917 and served with the U.S.S. DELAWARE which operated with the British Grand Fleet during World War I.

Admiral Noble

He attended the Postgraduate School at Annapolis, majoring in ordnance engineering. Later he attended Massachusetts Institute of Technology in Cambridge, Mass., receiving a master's degree in mechanical engineering in 1923.

Admiral Noble served with distinction in the Pacific during World War II and after the war was on duty with the Seventh Fleet during the Korean occupation. In June 1946 he was appointed Assistant Chief of Naval Operations (Material) and in 1947 was ordered to duty as Chief of the Bureau of Ordnance. Later he was assigned to duty as Chief of Naval Material with the rank of vice admiral and retired in October 1951 with the rank of admiral. At present he is the vice-president of the Nordberg Manufacturing Company, Milwaukee, Wis. Admiral Noble brings to this Division varied Navy experience as an ordnance authority with extensive combat and executive background.

The following three Committees of the Underwater Ordnance Division have been organized: Fire Control, Mines, and Torpedoes.

The Fire Control Committee of the Division is under the chairmanship of Lewis W. Imm, founder and president of Librascope, Inc., Glendale, Calif. He was born in Nebraska, raised in South Dakota, and attended the Universities of Minnesota and Nebraska.

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San Francisco, Los Angeles, Chicago (Nubian Division—1865 North Leclaire Avenue), Minneapolis, St. Louis, New Orleans, Cleveland, Atlanta, Reading. Canada: Toronto and Montreal.

He pioneered in aëronautical developments, being the first to develop an airplane using an automobile engine.

While with the U. S. Bureau of Air Commerce he invented the "balance computer," an analog device which simplified the cargo and passenger loading problems of airplanes in relation to their center of gravity, now used throughout the aviation industry. He founded Librascope, Inc., and has added to his inventions until it is one of the largest manufacturers of computers and components in the West.

The Division met at the U. S. Naval Base, Key West, Fla., on March 31-April 1, 1955, under the chairmanship of Admiral Noble. Organizational problems of the Division were discussed, and separate technical meetings of the Fire Control, Mines, and Torpedo Committees were held. All sessions were classified and the groundwork was laid for handling problems in the field of underwater weapons.

The Mines Committee has as its chairman J. McWilliams Stone, founder and president of the DuKane Corporation, formerly the Operadio Corporation. He was born in Chicago on September 11, 1896, was graduated from Armour Institute of Technology in 1920, and was a commercial wireless operator and marine engineer and trial trip engineer for the Bethlehem Shipbuilding Corporation prior to graduation.

Mr. Stone was vice-president of Van Dorn Coupler Corporation before entering the electronics manufacturing industry with his present company. He is a trustee of Illinois Institute of Technology and Lake Forest Academy. He brings to his Committee broad experience, technical knowledge, and proven ability in this Ordnance-industry field.

J. McW. Stone

The Mines Committee held a very fine classified meeting under the chairmanship of Mr. Stone at the Ordnance Mine Depot, Yorktown, Va., on March 28, 1955. The entire Committee and the advisory panel visited the depot and saw at first hand the scope of the activities with which this Committee is charged.

Capt. E. K. Walker, U.S.N., welcomed the Committee and met with it during its technical session. A complete tour of the depot was made by the Committee members and the advisory panel. A fine luncheon at the Officers' Club was followed by a further inspection of facilities. The meeting closed with an interesting technical session.

On March 29, 1955, the entire Committee held a meeting at the Franklin Street Annex, Naval Gun Factory, in Alexandria, Va. The excellent mine display was used as the basis for further discussion of the problems presented.

The Torpedoes Committee has as its chairman Dr. Gordon Russell Tatum. Dr. Tatum was graduated from Baylor University in 1928 and remained on the faculty until 1946 at which time he was professor of physics. He received his master's degree from the University of Texas in 1931 and his Ph.D. degree from Harvard University in 1937.

In 1941 he assisted in the organization of a course in fundamentals of electronics and communications engineering at Cruft Laboratory, Harvard University, for training of armed forces officers. In 1945 he became associate director of research and development with the Applied Physics Laboratory of Johns Hopkins University.

Dr. G. R. Tatum

In 1948 Dr. Tatum joined the Kellex Corporation, now the Vitro Corporation of America, as director of the Silver Spring Laboratory. In 1954 he became general manager of Vitro Laboratories, a division of Vitro Corporation.

Dr. Tatum is a member of the American Physical Society, Acoustical Society of America, and the American Association for the Advancement of Science. His scientific training and experience and his close association with work in the field of torpedoes portend great success for this Committee in its work.

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PERSONNEL CHANGES ARE ANNOUNCED

Paul O. Vogt, chairman of the Packing and Packaging Division, has asked to be relieved of that position after seven years of hard work. His successor is *John W. Kraus,* who has been chairman of the Preservation Committtee in this Division. Mr. Kraus's successor as chairman of the Preservation Committee will be announced later.

W. D. Gohr, deputy chairman of the Artillery Division, has been appointed A.O.A. Council member for the Artillery

Clarence W. Spicer

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DANA CORPORATION
looks ahead
to another 50 years of progress

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Clarence W. Spicer, who invented and mass-produced the first universal joint for automotive vehicles.

Charles A. Dana, whose wisdom of decisions has welded together the big family of Spicer-Dana plants and products.

Ralph E. Carpenter, who helped pilot the Spicer-Dana ship on a true course, through peace and war, through good times and bad.

Today, Spicer has available a 10-plant organization that embodies some of the most advanced efficiencies in the world. Spicer engineers are now on a program announcing a wide range of new and improved products. Many of these are revolutionary in performance. Spicer administration, sales and service have been sparked by new executives . . . new plans . . . *new action* in every department.

***Action* . . . that's what we promise you all along the line. *Action* . . . working together hand in hand with designers and engineers on vehicles of the future. *Action* . . . that will continue to develop power transmission units destined to further heighten the Spicer reputation as**

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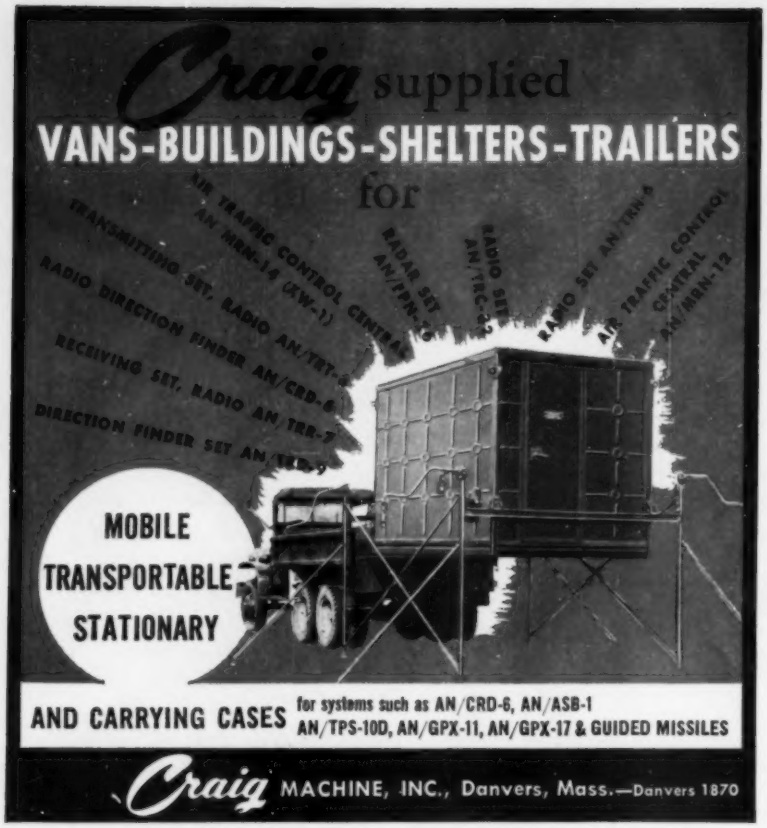


Divisions and Committees

Division, replacing *S. E. Skinner*, who has been elected to the Board of Directors of the Association.

John G. Pleasants, chairman of the Loading Committee of the Bomb and Artillery Ammunition Division, has resigned that position and has been replaced by *Harold S. van Buren* and *Brig. Gen. Joel Holmes*, U.S.A., Ret., cochairmen.

Ralph Cantlay has been appointed secretary of the Combat Vehicle Division.

BALL BEARINGS GROUP MEETS IN NEW YORK

The Instrument Precision Ball Bearings Committee of the Fire Control Instrument Division met on March 30th at the Engineers' Club, New York City, with F. E. Ericson as chairman.

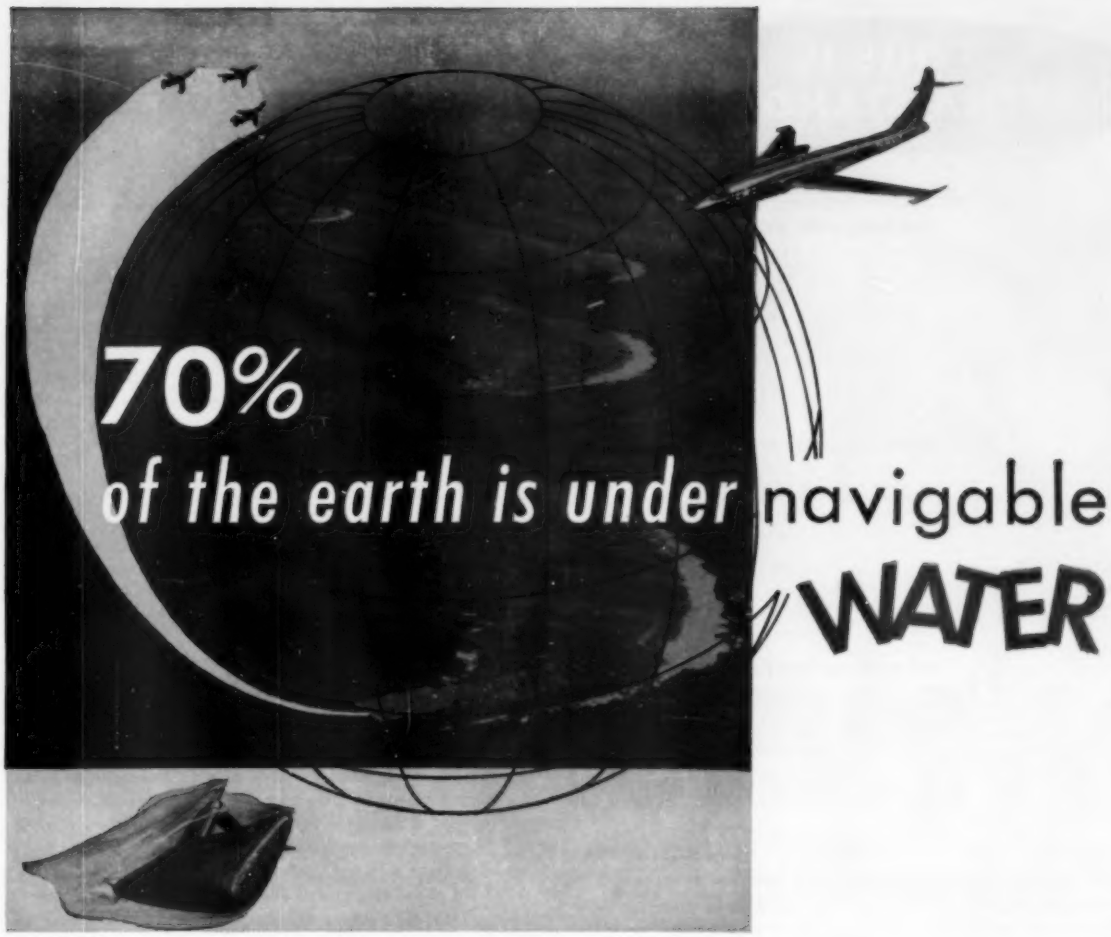
K. D. Mackenzie, chairman of the Torque Committee, reported on recommended changes to MIL-STD-206, stating that the invocation date of July 1, 1955, was impossible to meet.

• The chairmen of the Committees of the Guided Missile, Rocket and Jato Division met in the Pentagon on March 30, 1955, under the chairmanship of C. L. Eksergian. The organization of the Committees was continued and questions relating to service-industry relations were discussed. A joint meeting of the three Committees is planned for June 15-16, 1955, at the U. S. Naval Air Test Center, Point Mugu, Calif.

• The register of "first team" producers, known as the Alphabetical Register of Planned Wartime Matériel Suppliers, is being reduced by the Department of Defense from 34,000 names to 24,000. Plants are being deleted for such reasons as out of business, mergers, noncoöperation, and inability to produce items meeting the more rigid criteria of Department of Defense Directive 4005.6.

Firms should check their status. If you have been previously registered, consult your Armed Service Procurement Planning Officer (ASPPO), or any major Army, Navy, or Air Force Procurement Office, and verify your listing. This is important.

• Division and Committee chairmen are requested to send accounts of their meetings in to national headquarters as soon as possible after the meetings are held. Copy for each issue of ORDNANCE should be submitted at least six weeks before publication date. If the minutes are received promptly, the stories will appear while they are still of interest.



AND IT SERVES AS A MAJOR SPRINGBOARD FOR OUR NATION'S DEFENSE—WITHOUT DIPLOMATIC NEGOTIATION . . .

America's security and defense depend on absolute control of the vast ocean areas around us . . . the surface, under the sea, in the sky. Each is a possible avenue of attack from an enemy. Our control must enable us to

- use the sea
- deny it to the aggressor.

Effective surveillance of the great ocean areas is a paramount problem to our Naval Task Force Commanders. They must have electronic eyes, ears and brains to search for, detect and track enemy forces. With the data received from these electronic devices they can deploy our offensive and defensive forces so as to destroy the enemy. However, a Task Force's effectiveness depends upon thorough integration of the crew's individual functions into the electronic system that supports the operation.

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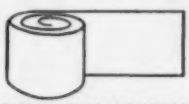
FLAT-ROLLED FINISHING EQUIPMENT

This is one of Aetna's six major product lines. Flat-rolled embraces such equipment as: Shearing and Classifying; Scrubbing and Drying; Recoiling; Slitting and Side Trimming; Roller Levellers (two-high and four-high); Reels of all kinds; and many other products.

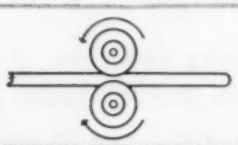


CONTINUOUS COATING

This year Aetna will have completed the building of 25 continuous galvanizing lines, in addition to several terne and electrolytic tinning lines. Aetna has worked closely with industry in this development and is considered the pioneer in continuous coating equipment.

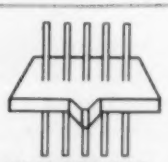
ROLLS

Aetna specializes in manufacture of small and medium-sized iron-base rolls. Aetna is pioneering in the use of Nodular Iron for rolls and castings under trade name of Magaloy.



CONTINUOUS BUTT WELD PIPE MILLS

Over the years, new ideas and engineering accomplishments have strengthened Aetna's position as the only builder in America of Continuous Butt Weld Pipe Mills. In recent months, Aetna Pipe Mill equipment has been installed in America, in Canada, in Germany, in England, in Japan and in Argentina.



COLD DRAWING

The world over, Aetna-Standard is recognized as the leading authority and builder of cold draw equipment for tubes and bars. This year marked introduction of several innovations by Aetna, such as the air gripper carriage and hook.

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GOOD EQUIPMENT BRINGS DOWN PRODUCTION COSTS

MATERIALS PROGRESS

George S. Brady

Developments in Electronic Designs.—So remarkable have been the developments in electronic designs in the past two years that a number of strategic materials which had appeared likely to be in extreme shortage in a war emergency may now come into a more favorable supply balance.

The need for greater compactness and less weight has been the dominant reason for radical redesign, but savings in scarce materials also have influenced the thinking, as well as continued research for alternate materials with improved operating characteristics.

Selenium is a good example of a material affected by new research developments. Since the selenium rectifier was hurried into production during World War II to replace the copper-oxide units, the chief use of selenium has been for rectifiers, and the material has been in almost chronic shortage. Its supply could not be increased at will since it is largely a by-product of copper production.

The demands for compactness and for a reduction of fifty per cent in the weight of military radio sets would have been impossible to attain with the use of selenium because of the necessarily large size of the selenium units.

The staff demands, therefore, however technically unreasonable they appeared a year ago, have been a blessing in disguise because they forced designers to push research on other semiconductors that would give greater capacity in less space, thus halting the mounting requirements for the scarce selenium.

Germanium was a natural substitute for selenium since a tiny crystal of the metal can give characteristics equal to a series of selenium plates many times the size. The crystals are easy to produce, and the supply of the metal is more reliable since, unlike selenium, it is not merely a by-product of other mining.

But germanium is not a complete answer for rectifiers as it is not capable of operating at the higher temperatures evolved when units have to carry maximum loads in confined spaces. Nevertheless, the germanium rectifier has made big strides in the past year and has actually opened new fields of use for rectifiers.

The *General Electric Company* is already in production on water-cooled germanium power rectifiers capable of replacing converter sets at large savings in space, which is particularly valuable for naval applications. A number of other companies are now offering germanium rectifiers and diodes that have made possible large reductions in the size and weight of electronic devices.

A new germanium crystal diode hermetically sealed in glass, being marketed by the *International Rectifier Corporation*, El Segundo, Calif., measures only 0.47-inch in length and 0.23-inch in diameter. Germanium transistors are replacing tubes in hearing aids and portable radios, and not only reduce size and weight but also increase the life of the battery almost twenty times.

Pure silicon metal crystals have been known for some time as excellent semiconductors capable of withstanding much higher temperatures than selenium or germanium. It has been costly to melt and purify silicon metal, but in spite of a high price, more than $400 a pound, practically all the rectifier manufacturers have silicon rectifiers at least in pilot-plant production. A method of producing the silicon crystals has been developed by *Westinghouse Electric Corporation* which should make the smaller and more efficient silicon rectifier competitive in price with the older selenium rectifier.

Model 145 Dart Truck equipped with Allison TORQMATIC DRIVE being loaded at Sunnyhill Coal Company's New Lexington, Ohio, mine. Truck is one of 10 operated by Sunnyhill

10 trucks replace 30 –cut costs 62%

WHEN 10 50-ton trucks equipped with Allison TORQMATIC DRIVES replaced 30 mechanical-drive 20- and 30-ton trucks at Sunnyhill Coal Company's New Lexington mine:

Operating costs dropped *18.6¢ per ton,*

Maintenance costs were cut *13.1¢ per ton,*

And the TORQMATIC*-equipped trucks now haul 32.6* more *tons per truck hour.*

But lower costs are only part of the story.

On-the-job accidents have dropped sharply. Drivers stay fresher, more alert because they now have no clutch pedal to push – quick-shift at full throttle with finger-tip hydraulic control—have only 3 shifts instead of 7 or 10.

Wet weather worries have almost disappeared—road maintenance costs are lower. Smooth power transmission by the Allison TORQMATIC DRIVES lets trucks drive through mud and muck—conditions that often shut down the mine before TORQMATIC-equipped units came on the job.

Big reason for lower operating and maintenance costs is shock-free power transmission by the *matched* TORQMATIC Converter-Transmission teams. The Converter absorbs shock loads instead of transmitting them along the drive line—protects engine, differential, drive shaft and transmission from damage.

There's an Allison TORQMATIC DRIVE for your 40- to 400-horsepower gasoline and Diesel equipment. New low-cost 40-150 h.p. TORQMATIC Converters easily fit present equipment, are completely self-contained for simple installation. Get full details about Allison TORQMATIC DRIVES from your equipment manufacturer or dealer or write:

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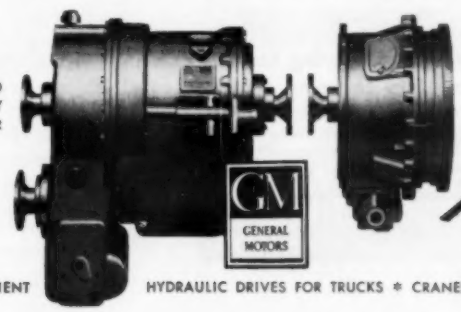
Unbeatable Team for Maximum Operating Economy

- **Quick-Shifts** at full throttle with finger-tip hydraulic control
- **Holds** power to load at all times – no clutch pedal to push—no gearshift guess
- **Reduces** maintenance costs by absorbing shock – eliminates engine lugging – prolongs equipment life
- **First** torque converter-transmission team designed to work as a *unit* and built by one manufacturer
- **Cuts** driver training costs

FIRST MATCHED UNITS BUILT BY ONE MANUFACTURER



Allison TORQMATIC DRIVES

COMPACT, EFFICIENT HYDRAULIC DRIVES FOR TRUCKS * CRANES * TRACTORS * SCRAPERS * SHOVELS * DRILLING RIGS

Materials Progress

Another new use for germanium is for light filters. *Baird Associates, Inc.*, Cambridge, Mass., has a new filter for infrared photo detectors which consists of a pure germanium single crystal ⅛-inch thick and 1⅛ inches in diameter. The crystal absorbs all wave lengths shorter than 1.8 microns and transmits the near and far regions of the infrared spectrum.

Nickel-Iron Battery.—The Edison Storage Battery Division, *Thomas A. Edison, Inc.*, West Orange, N. J., has a new nickel-iron storage battery that gives twenty-five per cent more power than a lead battery of the same size and suffers no appreciable injury by long storage. It also has the advantages that it is not injured by short-circuiting or by reverse charging. The battery is being made in sizes to fit into existing battery boxes.

Manganese Ores.—Success in attempts to utilize economically the superabundant domestic low-grade manganese ores is reported by the Bureau of Mines. After World War II the research was along lines of beneficiation of the ores for regular metallurgical processing, but the more recent developments are chemical.

Pilot-plant operations have been on Arizona ores containing only 9.5 per cent manganese, and recovery has been up to 90 per cent of the contained metal. The ore is leached with sulphur dioxide to form manganese sulphate and manganese dithionate, and the manganese is removed by precipitating it to form a hydroxide with lime (gypsum is a high impurity in the ore). The precipitated product is sintered to a mixture of Mn_2O_3 and Mn_3O_4. Cost of operation is low.

Asphalt-Rubber Roads.—For purposes of long-range study by the National Bureau of Standards and the Bureau of Public Roads, a section of MacArthur Boulevard in Washington, D. C., has been paved with an asphalt-rubber mixture. The material used was Latex R-504 of the *Firestone Tire & Rubber Company*, Akron, Ohio.

About ten per cent of latex was added to the asphalt. The latex solution is fifty per cent water, which gives steam dispersion of rubber particles as the water is evaporated by the heated aggregate during application, leaving five per cent rubber in the final mixture.

In other cities different methods of mixing the rubber have been used. In Rapid City, S. Dak., where the climate is subject to extremes of heat and cold, Ruberite was mixed directly with the asphalt. Ruberite, a product of *Ruberite, Inc.*, Magnet Cove, Ark. (Goodyear Tire & Rubber Company), is an unvulcanized synthetic rubber powder mixed with powdered barytes.

Aluminum-Tin Bearings.—Aluminum-tin alloys containing up to thirty per cent tin have been developed by the *Tin Research Institute*, Greenford, Middlesex, England, for Diesel-engine and other heavy-duty bearings. The new bearing alloys have good strength and fatigue resistance and have no tendency to seize. They are comparable in cost to copper-lead alloys.

Tin Plate Use.—The world use of tin for tin plate reached a peak of 68,500 long tons in 1941, and, in spite of an enormous increase in the use of metal containers since that time, the consumption of tin for tin plate remains well below prewar levels.

The reason is that the conservation methods applied during the war have proved economical. Electrolytic tin plate requires little more than forty per cent of the amount of tin formerly used. Also, lacquered cans have proved entirely satisfactory for many food uses.

Twistless Yarn.—Yarns without twist have been in demand for making lami-

NEW MONARCH
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MANUFACTURING
Rolling Case Body
Continuous Seam Welding
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Three modern plants ... stamping presses from ¼ to 500 tons capacity ... a highly skilled engineering department ... plus ample capacity for assembling and finishing—all of these are at your service when you contract with New Monarch.
More than 40 years of experience on countless, diversified jobs are your assurance of quality and dependability. Shown is the production line for a metal propelling charge container—but one of the many government contracts executed in our well-equipped and highly efficient plants. Our familiarity with high-precision government requirements can be of great help to you, whether on defense or civilian contracts.
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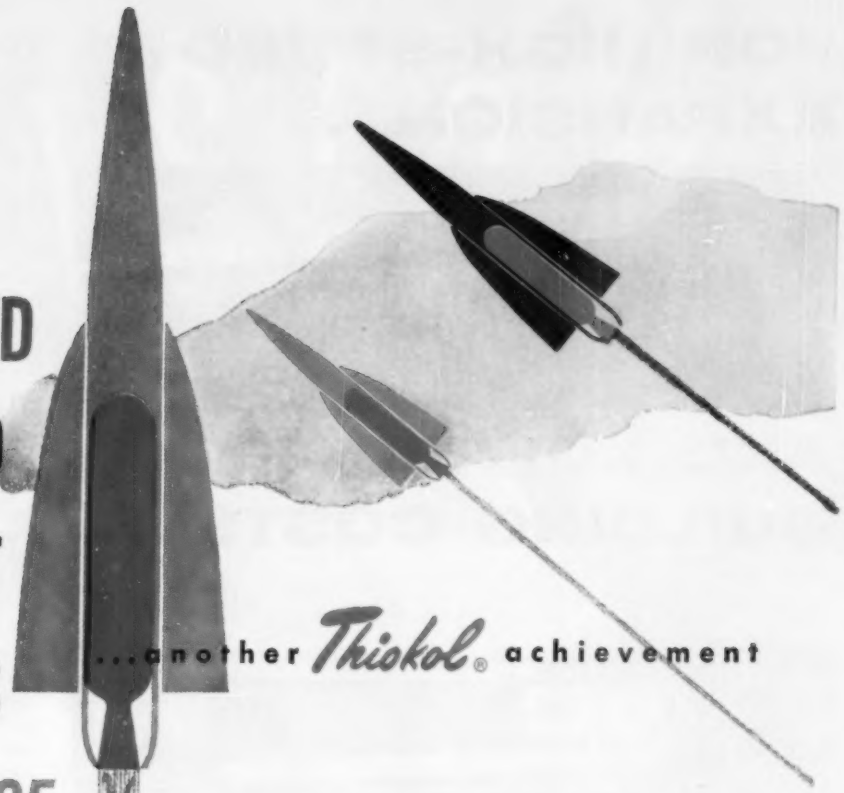

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Solid propellant propulsion and power units for:

All Types of Rockets
Guided Missiles
Boosters
Gas Generators
Aircraft Assist Take-Off Units
Short Duration Power Plants

Thiokol projects include participation in development programs on Douglas "Honest John," Armour Research Foundation "T-131," and Hughes "Falcon."

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Become a member of Thiokol's rocket development and manufacturing team! We welcome inquiries from mechanical engineers, chemical engineers and chemists interested in the rocket field.

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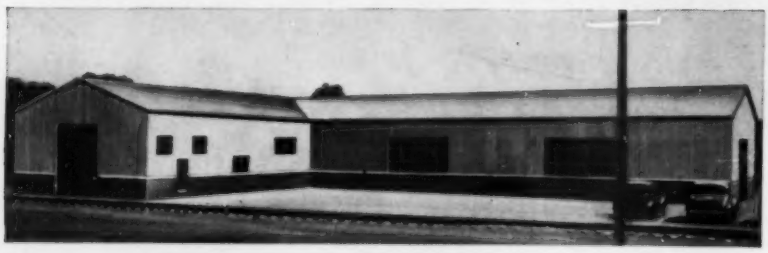
AND LOWER BUILDING COSTS . . .



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Materials Progress

nated plastics, but they have been difficult to produce satisfactorily. Now, a twistless yarn, called Tek-Ja, has been made possible with a new machine developed by *Proctor & Schwartz, Inc.*, Philadelphia, Pa., and *Fiberbon Laboratories*, Watertown, Mass. The machine takes the roving from a creel and draws it to the required weight, then feeds it through a press roll where it is impregnated with an adhesive.

Compressor Lubricant.—The new compact Model 4-D compressor produced by *Walter Kidde & Company*, Belleville, N. J., for actuating the controls, landing gear, and bomb-bay doors on jet aircraft delivers four cubic feet of free air a minute at all altitudes when pressurized from a jet engine. For weight saving, both the pistons and cylinder walls are of 24ST-4 aluminum alloy, with the cylinder walls chromium plated.

To prevent the aluminum from being scored during the break-in running (the compressor operates at 3,750 r.p.m.), a 0.050-inch coating of colloidal graphite in an epoxy resin dispersion is sprayed on and baked.

During the break-in run, the graphite from the hard-baked film penetrates the surface of the aluminum and in the later running is unaffected by oils, solvents, or heat to 500 degrees Fahrenheit. The graphite-epoxy material is being marketed by the *Acheson Colloids Company*, Port Huron, Mich., as Dispersion No. 213.

Aluminum Nails.—Aluminum nails are being used in increased quantities because of their nonstaining qualities. When used for nailing wood siding they do not require countersinking and puttying. New nail standards adopted by the *Aluminum Company of America*, Lancaster, Pa., include an increase of the gage of the nails and an improvement in the quality of the wire used. The new wire in 6061-T913 alloy with a minimum tensile strength of 63,000 pounds per square inch.

New Sheet Mill.—Practically all markets for aluminum have been expanding in the past year. Production of primary aluminum for 1954 was reported at 1,460,000 tons, or 16 per cent above the 1953 output. The new 144-inch mill installed by Alcoa at Davenport, Iowa, is producing tapered sheet up to ten feet wide for use on the new giant bombers. The large tapered sheet permits necessary wing strength with decrease in weight from the fuselage to the wing tip.

Corrosion-Resistant Signs.—The State of Virginia has now adopted aluminum as the metal for all highway signs. The State Highway Department maintains

VISION

GOVERNMENT PRODUCTS DIVISION

Vision...is a key word at Rheem.

Forward-thinking is a basic ingredient in all research, engineering and production processes and has been a major contributor to Rheem's enviable record of low-cost per unit production and on-time completion schedules.

Rheem's integrated Government Products Division facilities...strategically located on both East and West Coasts...are presently in quality production on air frames, missile and jet-engine components, airborne ordnance, electronics and ordnance materiel.

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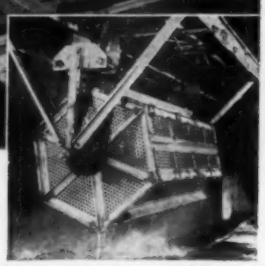
ARE

Alodized

WITH "ALODINE"®

for EXTRA PROTECTION

Man kneeling at left is adjusting faucet of "Alodine" tank. All tanks hold 5,500 gallons. Note simplicity of operation.

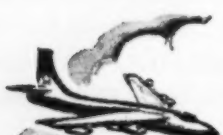


Small aluminum parts are Alodized in this power-driven squirrel cage tumbler.

Practically all painted aluminum aircraft parts at Temco are pre-treated with "Alodine."

Alodizing improves paint-bonding and enhances aluminum's natural corrosion-resistance.

Alodized aluminum effectively meets the requirements of Military Specification MIL-C-5541.



If it's aluminum, be sure it's Alodized.

Pioneering Research and Development Since 1914

AMERICAN CHEMICAL PAINT COMPANY

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CHEMICALS ACP PROCESSES

DETROIT, MICH. NILES, CALIF. WINDSOR, ONT.

Materials Progress

more than 185,000 directional and informational signs along the highways, and the annual cost of replacement, largely due to discoloration of the message by red rust streaks, has been about $75,000. The new signs are strong, light in weight, easy to install, and are very resistant to corrosion and free from staining.

Lightweight Walkways.—The *Blaw-Knox Company,* Pittsburgh, Pa., is marketing four new gratings for walkways in aluminum metal instead of the conventional steel. Besides the standard rectangular bar design, the company offers three other patterns with interlocked crossbars. The advantages claimed for the aluminum are light weight and no need for maintenance painting.

Aluminum Tank.—The first gas-fired water heater to use an aluminum tank is being produced by the *Ruud Manufacturing Company,* Pittsburgh, Pa., in four standard-size models. The tank is comparable in cost to glass or enamel-lined tank, requires no lining, is corrosion-resistant, and gives a long service life.

Plastic Tote Boxes.—Lightweight tote boxes for factory handling of production parts are now available in identifying colors and, where desired, with labels permanently molded into the plastic. The boxes, designated as Toteline by the *Molded Fiberglass Tray Company,* Linesville, Pa., are made of glass-fiber-reënforced synthetic resin. They have smooth glossy surfaces resistant to oils and chemicals and can be steam-cleaned since the material will withstand temperatures to 250 degrees Fahrenheit.

New Magnet Wire.—A new magnet wire developed for upgrading the horsepower of motors as much as twenty-five per cent without increasing the size is being produced by the *General Electric Company,* Bridgeport, Conn., under the name of Alkanex. The wire is insulated with a thin film of a polyester resin which has high dielectric strength and will withstand hot spot temperatures to 150 degrees Centigrade. The round wire comes in sizes from No. 13 AWG to No. 26.

High-Strength Steel.—A new high-strength, low-alloy steel for heavy-duty structural work is being marketed by the *Jones & Laughlin Steel Corporation* under the name of Jalloy No. 3. It contains a nominal composition of about 0.30 per cent carbon, 1.50 manganese, 0.25 silicon, 0.15 molybdenum, with not more than 0.04 per cent of sulphur and phosphorus.

UNITED

35,000 TON FORGING PRESS

A NEW 35,000 ton hydraulic forging press being built by UNITED for the USAF Heavy Press Expansion Program to help bring the United States to a commanding position in the production of modern aircraft for the armed services.

UNITED

ENGINEERING AND FOUNDRY COMPANY

Pittsburgh, Pennsylvania

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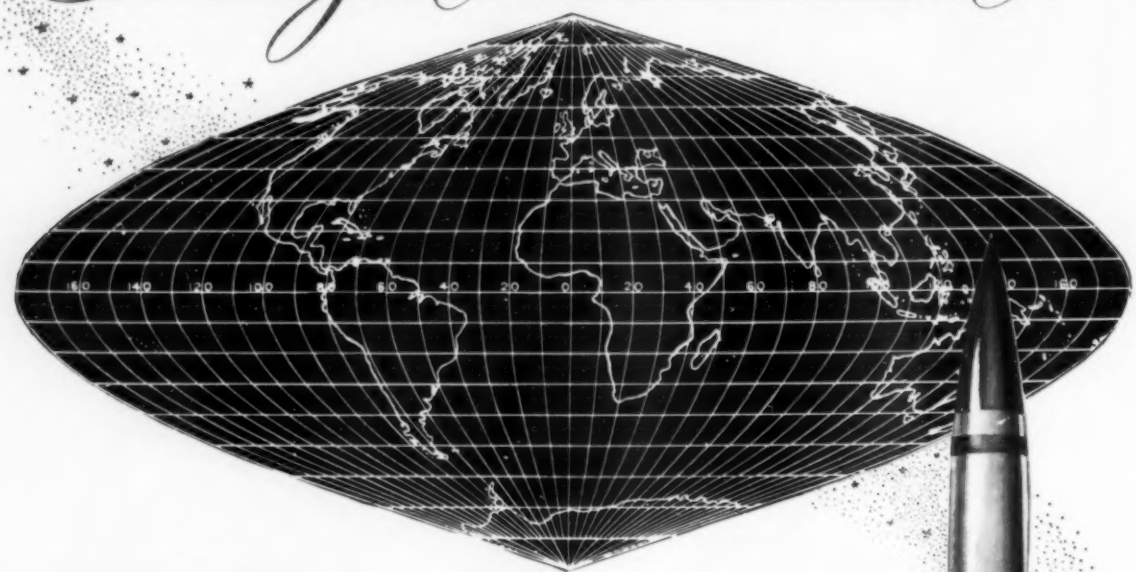
Designers and Builders of Ferrous and Non-Ferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other heavy machinery. Manufacturers of Iron, Nodular Iron and Steel Castings and Weldments.

Ten Years That Changed the World

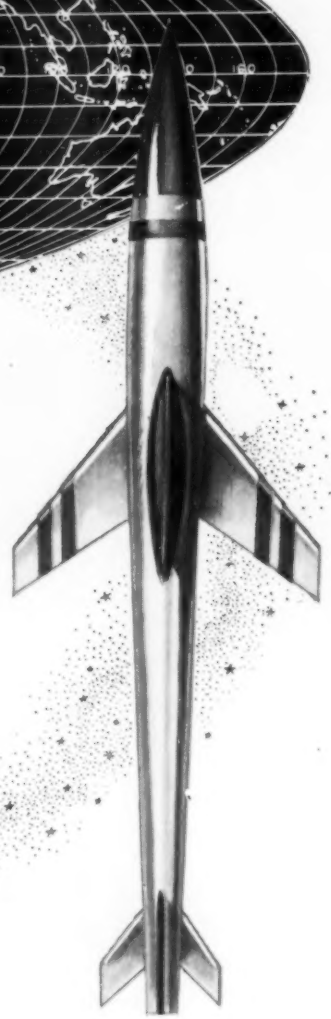


History records no more radical changes in the military sciences than those of the past decade. The period 1945-1955 saw not only the advent of nuclear weapons but, equally important, new systems of defense and new means of offense – guided missiles.

Just ten short years ago guided missiles were only a visionary concept. Today they are on the verge of becoming the base on which the security of Western Civilization and the peace of the world will rest. Although largely masked by the necessities of military security, tremendous strides are being made by all the branches of the U. S. Armed Forces in this crucial period.

The Fairchild Guided Missiles Division is proud to have a part in the missile programs of our Armed Services. Starting in 1945 with the first of this country's true guided missiles – the Navy's surface-to-air "Lark" – the Fairchild Guided Missiles Division has been continuously engaged in designing, developing and producing missiles, radar and associated equipment. It has supplied missiles and missile weapons systems to the Navy, the Air Force and the Army.

In the years ahead, Fairchild can be counted upon to continue its role as one of the leaders in our missiles program.



"where the future is measured in light-years"

ENGINE AND AIRPLANE CORPORATION

FAIRCHILD

Guided Missiles Division

WYANDANCH, L. I.

Other Divisions: Aircraft Division, Hagerstown, Md. American Helicopter Division, Manhattan Beach, Calif.; Engine Division, Farmingdale, N. Y.; Kinetics Division, New York, N. Y.; Speed Control Division, St. Augustine, Fla.; Stratos Division, Bay Shore, N. Y.

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ALLOY STEELS

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- N-A-X ARMORPLATE
- N-A-X 9100 SERIES

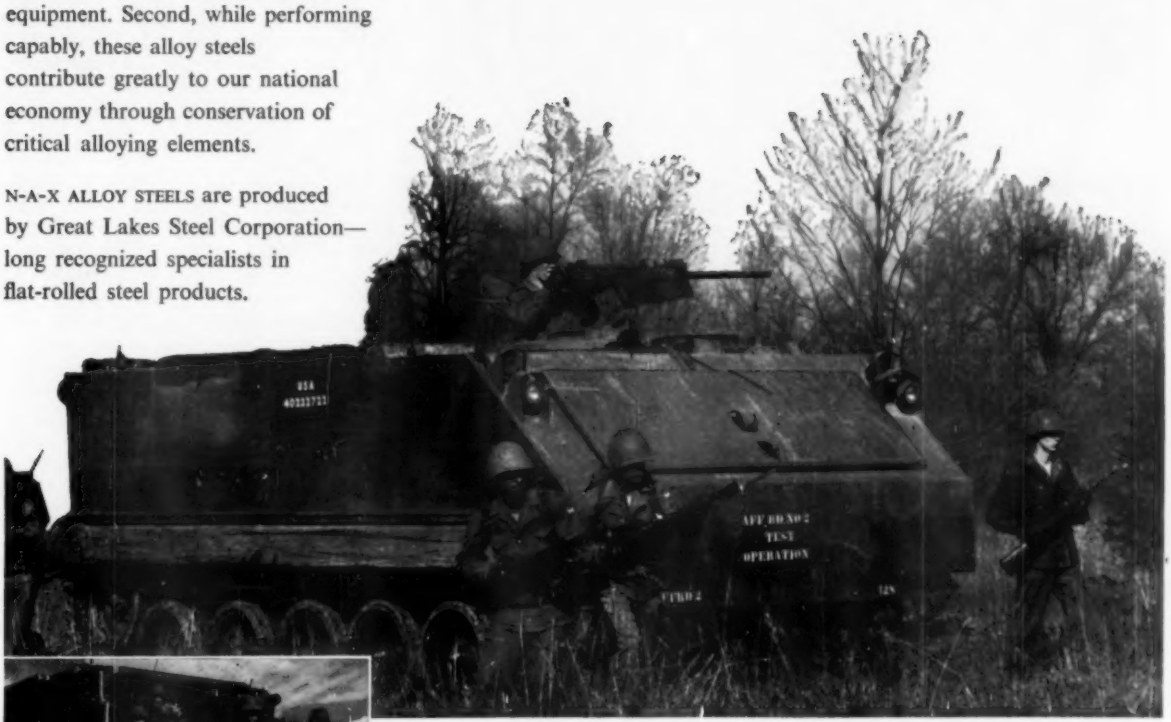
For National Defense Equipment

. . . Meet necessary rigid standards

. . . Conserve critical alloys

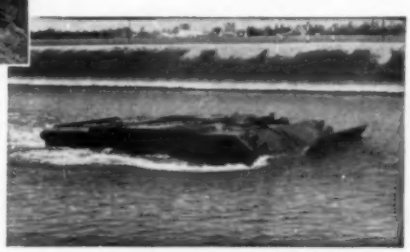
N-A-X ALLOY STEELS in national defense equipment serve a dual purpose. First, they readily meet the rigid standards so necessary in this type of equipment. Second, while performing capably, these alloy steels contribute greatly to our national economy through conservation of critical alloying elements.

N-A-X ALLOY STEELS are produced by Great Lakes Steel Corporation—long recognized specialists in flat-rolled steel products.



The M59 Armored Infantry Vehicle, designed and built for Army Ordnance by Food Machinery and Chemical Corporation, is an example of national defense equipment using N-A-X ALLOY STEELS.

An infantry squad leaving their M59 armored personnel carrier to assume battle positions, after being safely transported to the scene of action.



Although primarily a land vehicle, the M59 is capable of swimming rivers and lakes with ease, while fully loaded.

N-A-X Alloy Division

GREAT LAKES STEEL CORPORATION

Ecorse, Detroit 29, Mich. • A Unit of

NATIONAL STEEL CORPORATION

THIS CLEVELAND CONTAINER

made for

Heavy Duty

. . . with reinforced metal ends

The heavy wall is spirally wound, with multiple layers of high grade paperboard, closely butted and evenly bonded with adhesive to give extra strength and long use.

Moistureproof . . .

Immune to wear and tear . . .

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Excellent for shipping plated metal strips, shafts, rods, tubes and many other metal parts . . . also, used as cores for paper rolls and fabrics; bodies for reels; liners for metal drums. Available in diameters and lengths as desired.

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Materials Progress

It can be heat-treated to a hardness of about 380 Brinell. It has good abrasion and wear resistance and is also available with 0.20 per cent copper for uses where resistance to atmospheric corrosion is desired.

Nonirritating Iodine.—Iodine is one of the best and most economical disinfectants for general industrial use, but has been objectional because it is staining and irritating to the skin. Now, an odorless, nonstaining, and nonirritating form of iodine is being marketed by the *West Disinfecting Company*, Long Island City, N. Y., and is designated as Wescodyne.

Plastic Coating.—For the protective coating of tanks, ducts, and chemical processing equipment, the *Gates Engineering Company*, Wilmington, Del., has a new liquid Neoprene containing aluminum powder pigment. The material may be applied by brushing, rolling, dipping, or spraying, and it cures to a thermoset adherent coating that has the corrosion resistance of the Neoprene and the heat- and light-reflecting qualities of the aluminum.

High-Impact Molding Material.—Two new high-impact polystyrene molding materials for making such products as appliance parts and pipe fittings are now being produced in commercial quantities by the *Bakelite Company*, New York, N. Y., and marketed as TMD-5151 and TMD-2155. They combine high toughness with good moldability, and produce parts with a smooth finish in a wide range of opaque colors.

The material is rubber-modified polystyrene, and the extra-high-impact grade, TMD-2155, has a tensile strength of 4,500 pounds per square inch, elongation of 25 per cent, Rockwell M hardness of 25, and dielectric strength of 515 volts per mil. The heat-distortion point is 184 degrees Fahrenheit.

Plastic Pipe.—Plastic pipe is forging ahead and setting new records of use in industrial installations. It has also been successfully tested for cold-water installations in housing, but there has been a reluctance on the part of builders to specify it. Much of the piping used is unplasticized polyvinyl chloride and polyethylene.

The *Acheson Dispersed Pigments Company*, Philadelphia, Pa., working on a research project with *Godfrey L. Cabot, Inc.*, Boston, Mass., have found that higher loadings of carbon black will greatly increase the bursting strength of polyethylene pipe, and that for many purposes it is superior to metal pipe because of the ease and flexibility of installation and its resistance to corrosion.

the BENDIX IGNITION ANALYZER

the only way to make a COMPLETE, POSITIVE, DYNAMIC check of the ENTIRE Ignition System . . . without removing the engine

Result: tanks in action not in repair depots

Preventative maintenance is vital to the success of tanks or armored vehicles on the field of battle.

Fortunately in the case of ignition systems, incipient failure or intermittent malfunctions can be spotted immediately with the Bendix Ignition Analyzer. This provides *real* preventative maintenance.

The Bendix Ignition Analyzer gives a dynamic test of the entire ignition system in operation, outmoding time-consuming static testing of individual components. It is the easiest (checks the entire ignition system in the *field*) and the fastest (locates *any* ignition fault immediately) method of preventative maintenance ever devised for checking ignition efficiency in military vehicles of all types.

Descriptive folder available on request.

Here's How It Works —

The Bendix Ignition Analyzer provides a visual picture of the *actual* voltage waveform patterns occuring at the spark plugs. Normal ignition produces a characteristic normal waveform pattern. Likewise *any* abnormal ignition condition will produce its characteristic abnormal pattern. Interpretation of the patterns identifies and locates any ignition troubles immediately.

Bendix

The Bendix Ignition Analyzer safeguards ignition systems in all types of military equipment.

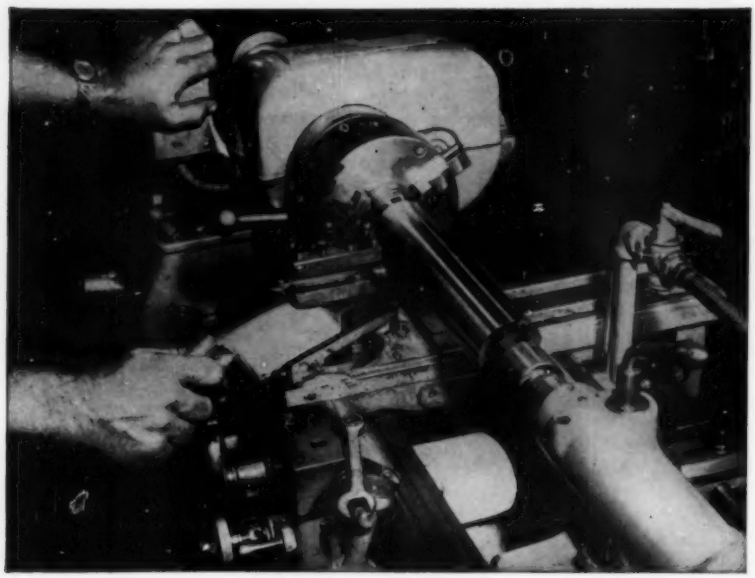
SCINTILLA DIVISION OF Bendix AVIATION CORPORATION
SIDNEY, NEW YORK

Export Sales: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

FACTORY BRANCH OFFICES: **117 E. Providencia Avenue, Burbank, California • Stephenson Building, 6560 Cass Avenue, Detroit 2, Michigan • 512 West Ave., Jenkintown, Pennsylvania • Brouwer Building, 176 W. Wisconsin Ave., Milwaukee, Wisconsin • 8401 Cedar Springs Road, Dallas 19, Texas American Building, 4 South Main Street, Dayton 2, Ohio**

MALLORY·SHARON reports on

TITANIUM



NEW ALLOYS easy to machine

PRODUCTION results and thorough research tests show that unalloyed titanium machines similar to 18-8 stainless steel. The alloy grades machine somewhat harder, but do not approach the difficult-to-machine high temperature alloys.

For example, Mallory-Sharon titanium alloys may be turned at 120 to 160 feet per minute, or milled at 80 to 120 feet per minute, using carbide tools. These rates are practical with the new Mallory-Sharon alloys MST 6Al-4V, and MST 3Mn Complex, and for the well-known MST 3Al-5Cr, and MST 4Al-4Mn alloys.

All Mallory-Sharon alloys are produced by "Method S" vacuum double melting, resulting in good machineability. This process eliminates alloy segregation and enables carbon to be held under 0.1%. (Carbon solubility in titanium is approximately 0.2%, and larger percentages result in formation of carbides which reduce machineability.)

For complete information, write for a copy of "Titanium Machining Recommendations". It is based on our broad experience as a leading producer of this lightweight, corrosion-resistant metal. Write Mallory-Sharon Titanium Corporation, Dept. E-5, Niles, Ohio.

MALLORY Ti SHARON

COMMUNICATIONS

PRODUCTION STUDIES

THE EDITOR.—I have read the January-February 1955 issue of the ORDNANCE magazine and wish to extend my compliments to your organization for the excellent articles contained therein.

One of the feature articles entitled, "Key to Conversion," by Lieut. Col. George S. Quick, refers to industrial mobilization planning. Assumptions have been made that little has been done by the armed forces in the area of industrial mobilization studies at the production-line level.

The author states that there has been much study and planning devoted to solving the "big-picture" problems associated with industrial mobilization and that relatively little has been done at the plant and product level.

This statement is inaccurate, since a great deal of work has been and will continue to be done to resolve the production problems.

The Department of Defense has established criteria which require extensive planning by the services for specific end items. The technical services assigned procurement responsibility for these end items have been preparing detailed plans which extend down to the actual production lines for plants and subcontractors required to turn out the critical components, subassemblies, and end items.

Critical tooling is acquired for industrial reserve and assigned to designated M-Day production programs.

Industrial-preparedness measures are conducted by contract with industry for engineering studies and to improve or modify production techniques or to educate industry through educational production projects and actual plant-scale manufacture.

In this manner industry gains experience, production techniques are developed, and potential bottlenecks are removed.

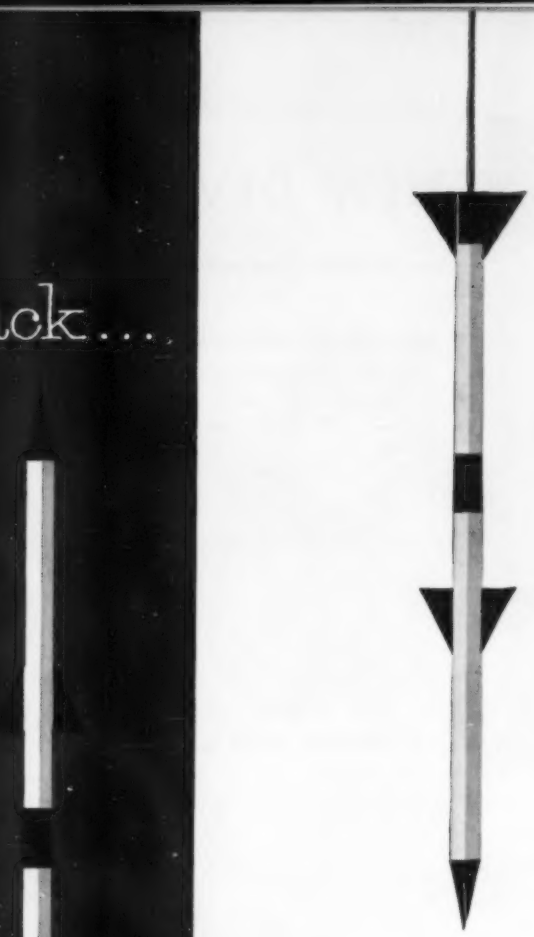
The commanding officers of each field installation are designated as the Armed Services Procurement Planning Officers. At this level of planning, the policies developed by higher authority are implemented in close contact with industry.

In this capacity the product-level planning is applied to the program and, of necessity, considers the production-line problems in specific plants required to produce the critical military items for which planning is authorized by the Department of Defense.

PAUL A. LONGO

Roslyn Heights, N. Y.

Attack...



or intercept

Electronic computers for national defense

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Inquiries from the land, sea and air forces are invited concerning our current activities in basic research, engineering development and volume precision production of equipment in all of the above fields. Address inquiries to Burroughs Corporation, Detroit 32, Michigan.

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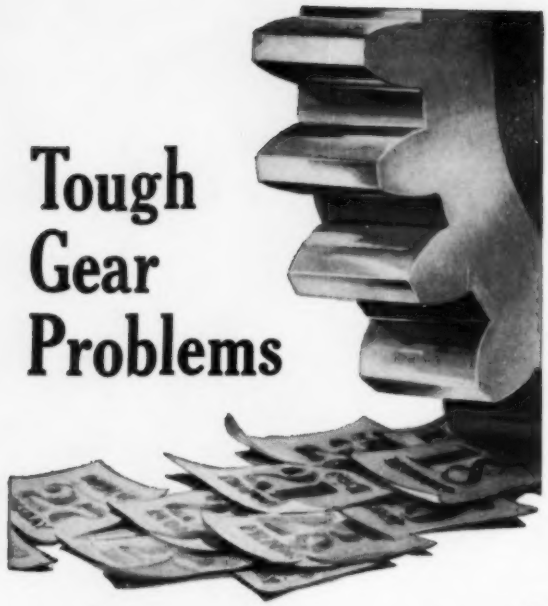

Tough Gear Problems

eating up your time?

Dependable solutions to tough gear application and design problems are our specialty. Solutions in time to meet your most exacting production schedules!

For over 50 years our engineers have concentrated on these problems... accumulated knowledge that has often proved to be the quickest and surest way out.

What's more, Fellows has the equipment best suited to your needs for cutting, finishing and testing... whatever they may be.

That's why a call or letter to us may solve your present gear problem... saving time and headaches. There's no obligation, of course.

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NEW DEVELOPMENTS

THE ATLAS MISSILE

The Air Force has recently revealed some details of the Atlas, an intercontinental guided missile capable of striking trans-oceanic targets from bases in this country within a matter of minutes.

The powerful new missile was disclosed by Gen. Nathan F. Twining, Air Force Chief of Staff. He said the Atlas is still in the early stages of development and has not yet been tested.

The rocket-powered missile will have a 5,000-mile range and attain a speed of 10,000 miles an hour. It is our first intercontinental missile.

The new weapon is expected to have something like ten times the accuracy and twenty-five times the range of the V-2 rocket used by the Germans in World War II.

The Atlas is being manufactured by the Convair Division of General Dynamics Corporation.

COMPUTER AIDS MAPPING

An electronic computer which Army engineers call a great advance in the history of map making was unveiled recently at a joint meeting of the American Society of Photogrammetry

Electronic computer being checked before shipment.

and the American Congress of Surveying and Mapping. Called "Monrobot V," the new computer was specially designed for the Corps of Engineers' Research and Development Laboratories by the Monrobot Corporation, electronics division of the Monroe Calculating Machine Company. It is expected to make figuring faster, easier, cheaper, and more accurate by reducing complicated engineering calculations to a minimum. Exceptionally rugged, Monrobot V will be used by the Army for map-making computations in the field and will be moved from place to place by truck.

TITANIUM LABORATORY

A titanium metallurgical laboratory has been established by the Department of Defense under contract with the Battelle Memorial Institute, Columbus, Ohio. Donald A. Quarles, Assistant Secretary of Defense (Research and Development), recommended the establishment of this laboratory to provide a source of comprehensive technical advice on titanium metallurgy needed at present by Government contractors and their suppliers.

PEACE...through strength

To our top political and military leaders it has become obvious that the one thing that will deter Communist aggression is the military might of the free world. **TEMCO,** in its dual role as civilian manufacturer of gas appliances and supplier to the Armed Forces, is proud of the part it has played in producing shells and bombs during both World War II and the Korean conflict...and of its present role as a peacetime manufacturer of ordnance items. **TEMCO,** anxious to use to the fullest its industrial experience and production facilities, invites inquiries from all branches of the Armed Forces.

★ A wide range of modern industrial equipment.
★ Extensive field testing facilities.
★ Adequate modern manufacturing space.
★ Statistical control procedures to insure meeting highest quality standards.
★ Tight security system and fire prevention controls.
★ Unlimited electric power and ample natural gas.
★ Comprehensive research facilities.
★ Competent and experienced personnel.

For complete, specific details, send for TEMCO's *"Supplier to the Armed Forces"* booklet.

TEMCO, inc.

NASHVILLE, TENNESSEE

New Developments

The Department of Defense expects that the titanium industry will eventually assume this function.

Initially, the Titanium Metallurgical Laboratory will concentrate on gathering and disseminating information and providing technical advice to industry on the production and application of titanium for military equipment. The laboratory also will assist and advise the Research and Development Coördinating Committee on Materials of the Department of Defense in its appraisal of the Department's titanium research and development program.

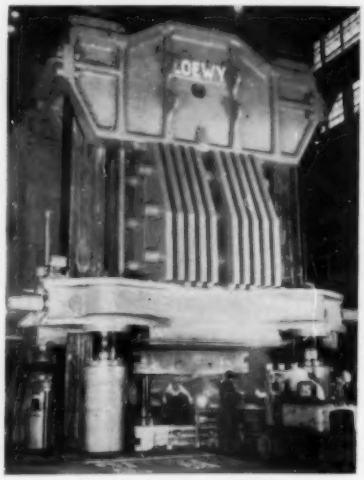
FASTEST SUBMARINE

The Navy has taken the wraps off an experimental submarine that is probably the fastest ever built. Called the U.S.S. ALBACORE and under test for the past year, it has controls similar to an airplane and is shaped like a fish. The ALBACORE was mapped out on the drawing board in 1948 and constructed at the Portsmouth Naval Shipyard, N. H. The fishlike design may become the pattern for future nuclear-powered subs.

Because of this radical design, unusual methods are used to operate the ship. While the ALBACORE is probably the fastest fleet sub for short runs, the atomic-powered NAUTILUS has faster sustained speed.

GIANT AIRCRAFT PRESS

The first giant closed-die forging press in the Air Force heavy-press program is now in production at the Wyman-Gordon



The 35,000-ton forging press.

Company plant, North Grafton, Mass. The first forgings off the press were of an original order for aluminum wing spars for the new F-102, a delta-wing, supersonic, all-weather interceptor being built by the Convair division of General Dynamics Corporation for the Air Force.

The 35,000-ton press is hydraulically activated. It has a dead weight of 7,180 tons, and its "accessories" have a total weight as great as that of the press itself. The pressure is developed by three 1,500-horsepower pumps, and water-storage facilities hold 125,000 gallons. The water is "primed" with special oil as a rust preventative and is reused.

Designed by the Loewy Construction Company of New York, the press has an international flavor, as parts were fabricated in the United States, England, France, Canada, and Italy. The 4 columns, each weighing 145 tons, were forged by Bethlehem Steel and are the longest forgings ever produced in this country. The four crossbars were cast in Sheffield, England. Two of them were machined at the Wyman-Gordon plant with tolerances as low as seven thousandths of an inch. Each crossbar weighs 207 tons. The press stands 45 feet above the operating floor of the shop and extends 62 feet below it.

GERM COUNTER

An instrument which may give instant warning of an enemy germ warfare attack has been developed by an Army Chemical Corps engineer at Camp Detrick, Md. The device, known as aerosoloscope, was developed by Nelson E. Alex-

For long life under extreme conditions of shock, vibration, corrosion, humidity and temperature

Bendix W type

HEAVY-DUTY

ELECTRICAL CONNECTOR

Here is the electrical connector designed and built for maximum performance under rugged operating conditions.

Intended for use with jacketed cable and not requiring ground return through mating surfaces, this connector incorporates sealing gaskets at all mating joints.

W-Type Bendix* Connectors also incorporate standard Scinflex resilient inserts in established AN contact arrangements.

Shell components are thick-sectioned high-grade aluminum for maximum strength. All aluminum surfaces are grey anodized for protection against corrosion.

It will pay you to remember that for the really tough jobs, where ordinary electrical connectors just won't do, be sure to specify the W-Type Connector. Our sales Department will gladly furnish complete specifications and details on request.

* TRADE-MARK.

SCINTILLA DIVISION

Bendix AVIATION CORPORATION

SIDNEY, NEW YORK

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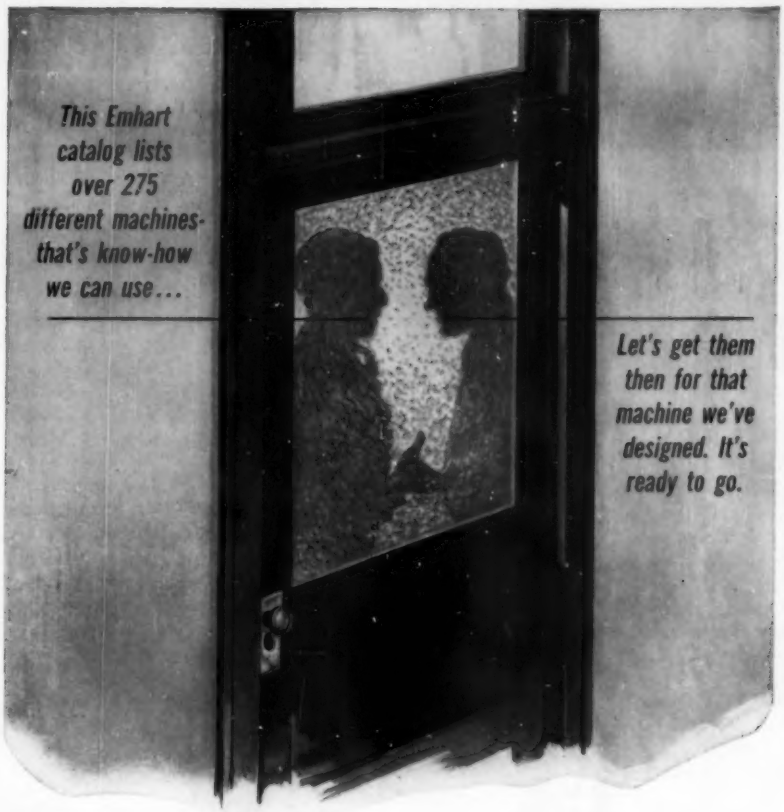
This Emhart catalog lists over 275 different machines- that's know-how we can use...
Let's get them then for that machine we've designed. It's ready to go.

For machine development and manufacture, see EMHART

It makes positive sense to put a certain machine building project into Emhart's hands. Each of the four divisions specializes in manufacturing machines. Each division is an acknowledged leader in its field. The combined experience of all four is probably unequalled in diversity.

Henry & Wright, for example, builds high speed machines for progressive metal stamping; V & O builds power presses and equips them in numerous ingenious ways; Hartford-Empire builds complete glassware production lines; and Standard-Knapp makes automatic packaging equipment.

Our central research and development group is available for consultation in Hartford or we can send a representative. If you would like more information, please write for our condensed catalog and literature describing Emhart facilities for defense requirements.

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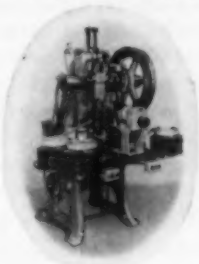
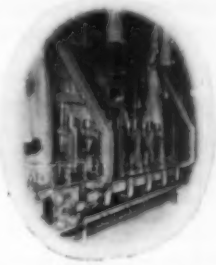
Only the best is good enough

PACKAGING MACHINES

POWER PRESSES



GLASSMAKING EQUIPMENT



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EMHART DIVISIONS

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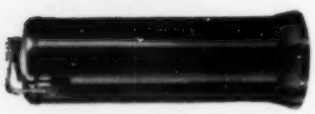
NIKE:
PROOF POSITIVE

NIKE, a tactical air-defense weapon that is rapidly being installed by the U.S. Army in and around our most strategic defense areas, has demonstrated the reliability and producibility of rocket power.

Under subcontract to the Douglas Aircraft Company, which is associated with the Western Electric Company, prime contractor on NIKE, Aerojet-General developed the sustainer rocket motor for NIKE and is producing them for Douglas in large quantities.

The largest industrial organization devoted exclusively to the development and production of rocket powerplants, Aerojet-General is supplying new, bigger and better rocket power for the Nation's defense program.



- **Solid- and Liquid-Propellant Rocket Powerplants for Missile and Aircraft Applications**
- **AeroBRAKE Thrust Reversers (SNECMA)**
- **Auxiliary Power Units and Gas Generators**
- **Electronics and Guidance**
- **Ordnance Rockets**
- **Explosive Ordnance and Warheads**
- **Underwater Propulsion Devices**
- **Architect-Engineer Services for Test Facilities**

Aerojet-General CORPORATION

A Subsidiary of The General Tire & Rubber Company

THE GENERAL TIRE

AZUSA, CALIFORNIA
CINCINNATI, OHIO
SACRAMENTO, CALIFORNIA

MORE POWER FOR AIR POWER

New Developments

ander. It measures and counts microscopic airborne germs, dust, and moisture particles—one at a time—at the rate of one hundred a second. It also will count radioactive particles and determine their size. Extensive use of the instrument is foreseen in public health agencies and industry to trace the source of such pollutions as smog.

Airborne particles ranging in size from one micron (forty millionths of an inch) to 64 microns are counted and measured by the aerosoloscope 1,000 times faster than by the ordinary method of collecting them in a medium or on a suitable surface and examining them through a microscope.

As the particles in concentrations of up to 15,000 per milliliter pass through the instrument they are diluted, and their flow rate is controlled in such a way that each one is individually illuminated. The reflection caused by the illumination is detected by a photomultiplier tube. Since large particles reflect more light than small ones, the photomultiplier tube, in conjunction with other electronic apparatus, is able to determine the size of each particle.

WHEELED SNOW TRAIN

The world's largest vehicle on rubber tires—a truck so big it will carry ten freight vans piggyback—will soon be doing just that across frozen snow trails of inland Alaska. Called the LeTourneau Sno-Freighter, the 274-foot transporter will be used by Alaska Freight Lines, Inc., to provide an overland freight link between areas normally isolated for part of the year by winter cold and snow.

Power-control car heads Sno-Freighter.

The Sno-Freighter consists of a power-control car and five cargo cars, each with a load capacity of twenty-five tons. Individual cars can be uncoupled for loading and unloading. Diesel-electric generating sets on the power-control car supply electric power to the twenty-four electric wheels which actually drive the vehicle. In this new system for delivering driving power, each wheel has an electric motor and gear reduction inside its rim. Low-pressure tires, eighty-eight inches in diameter and thirty-eight inches wide, are mounted on the wheels for traction and flotation over snow and frozen surfaces.

COMPLETE ELECTRICAL TESTING of giant FPS-7 radar search antenna being made on G.E.'s modern pattern test range. This range can test radiation patterns of all sizes in all standard radar frequencies and is the final step in making sure all radar antennas meet operational performance requirements.

Why G-E precision antennas can make your radar systems more effective

Advanced quality control and testing techniques enable General Electric to give you highly reliable precision antenna equipment that will help your radar system give maximum potential range and accurate return-signal interpretation.

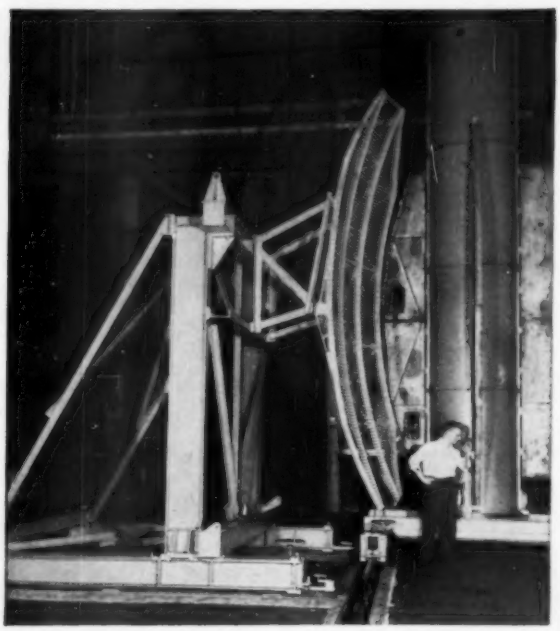
For example, the meeting of precise mechanical design requirements of radar reflectors is checked to within one hundredth of an inch by G.E.'s Contour-Checking Tower. Electrical performance is completely tested on a modern pattern testing range.

For information on how G.E. can help you with radar antenna research, development, design, manufacturing, and field servicing, contact your nearest G-E Apparatus Sales Office or write for bulletin GEA-6279. Section 223-1, General Electric Company, Schenectady 5, N. Y.

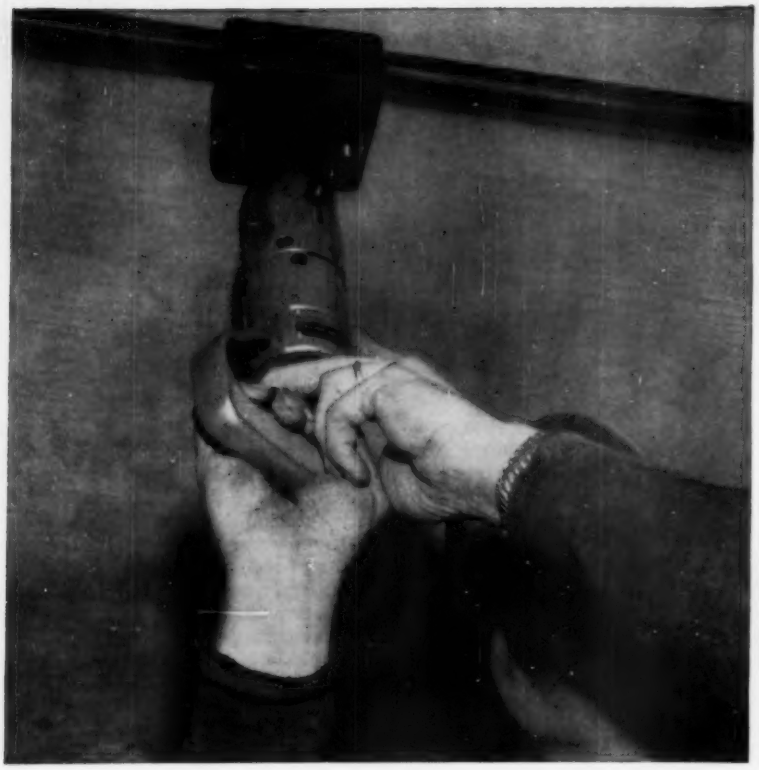
Progress Is Our Most Important Product

GENERAL ELECTRIC

PRECISION MECHANICAL INSPECTION to assure the meeting of exacting contour design requirements is being made here with the aid of G.E.'s Contour-Checking Tower. Antenna contours up to thirty feet by forty feet can be checked to within one hundredth of an inch through the use of this unique facility.



G-E SPS-8, one of the first shipboard height-finding and search radar antennas, had astigmatic parabolic reflector which presented difficult quality control problems. High accuracy of construction was maintained through the precision inspection afforded by General Electric's Contour-Checking Tower.



Save Up to 80% on Fastening Costs with the REMINGTON STUD DRIVER

"Cuts my conduit anchoring cost by an average of 74%"—writes one electrician about his Remington Stud Driver, and it's a typical report. With a speed of up to 5 studs per minute, this powder-actuated tool is bringing new economy to the job . . . new opportunities for electrical contractors.

Many maintenance men are finding they can speed up installations, get more jobs done with the Remington Stud Driver. Others tell us that the tool's light weight—6 lbs.—makes overhead work a lot easier. All are agreed that you can't beat the Stud Driver for setting studs in concrete and steel.

What's your fastening job? Whether you're fastening eye bolts for stringing wires or conduit clips to concrete, you'll save money with the Remington Stud Driver. For further information on how this amazing tool can help solve your fastening problems, mail the coupon below.

"If It's Remington—It's Right!"

Remington DUPONT

Listed and Approved by Underwriters' Laboratories, Inc.

QUESTIONS YOU ARE ASKING

QUESTION

Where can I get information about the guards that many maintenance men have been using for special applications?

ANSWER

Just send the coupon below, we'll be glad to supply you with a description of all the guards and their uses.

MAIL THIS COUPON TODAY

Industrial Sales Div., Dept. O-5
Remington Arms Co., Inc.
Bridgeport 2, Conn.

Please send me a *free* copy of the new booklet showing how I can cut my fastening costs.

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Position _____

Firm _____

Address _____

City _____ *State* _____

New Developments

RB-36 CARRIES FIGHTER

The U.S. Air Force's first squadron of RF-84F Thunderflash reconnaissance fighters equipped to operate from RB-36 reconnaissance bombers has been activated at Great Falls Air Force Base, Mont. The jet fighter airplanes will be equipped to be carried, launched, and recovered in flight by the RB-36's, with a great resulting increase in their range. They will also be capable of performing the mission of a reconnaissance fighter in the conventional way, taking off and landing on their own.

NEW PISTOL DESIGN

Probably no competitive pistol and revolver shooter but has had the annoying experience of having his "gun hand" stung by minute bits of burning powder grains

Iver Johnson single-action revolver.

which escape at the junction between cylinder and barrel of a revolver fired by a fellow shooter in an adjoining indoor booth, or standing next to him on an outdoor firing line.

However, there has now arisen a maker, the Iver Johnson Arms and Cycle Works of Fitchburg, Mass., which has decided that this drawback should and can be eliminated. To effect this the muzzle end of the cylinder is counterbored, which provides a solid rim guard around the cylinder diverting the flash, directing it forward and downward away from the shooter or companions standing near by.

Cylinders embodying this feature are now supplied throughout their entire revolver line. This includes, incidentally, a fine new single-action target model with light, crisp, trigger pull which is designated the "Armsworth."

GLOBAL NAVIGATION AID

Far-ranging jet aircraft will receive extremely long-range navigation aid from an experimental radio station to be constructed at Camden, N. Y. The station is the first experimental step in providing worldwide navigational information to military and commercial aircraft. Using a new long-range system called Navarho developed by the Air Research and Development Command's Rome Air Development Center, Rome, N. Y., the station will beam information 2,500 to 3,000 miles in all directions.

A single Navarho station can cover an area bordered by the West Coast of the

How to assign your COMPLETE SYSTEMS RESPONSIBILITY

Whether it's radar, countermeasures, missile guidance, sonar, computers, microwave or radio communications—electronic equipment of *any* kind—Raytheon has proved its capacity to shoulder *complete systems responsibility*. And "complete" means just that: *every* step—from design concept to operation and service.

Some 18,000 skilled, hand-picked scientists, engineers and assemblers working with some of the most advanced facilities in the industry have built Raytheon's reputation for "Excellence in Electronics." Write now for additional information.

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PEARLITIC MALLEABLE CASTINGS

when operating conditions . . .

. . . are severe

If service conditions are unusually rugged and you're troubled by high manufacturing costs—look to pearlitic malleable castings!

Pearlitic malleable has high fluidity that casts easily into complicated shapes. It resists wear under heavy loads at high speeds . . . has high ultimate strength . . . possesses excellent non-seizing properties for bearing surfaces . . . can be given a very smooth finish where desired . . . and can be either liquid quenched or air quenched And perhaps *most important of all, pearlitic malleable machinability index ranges from 80 to 90* (B1112 steel = 100).

So look your product over critically. Then check pearlitic malleable castings. They can replace more expensive methods of fabrication or manufacture . . . can lead to reduced weight, less machining time . . . fewer assembly operations . . . *greater sales appeal for your product.* AA-106

NATIONAL MALLEABLE AND STEEL CASTINGS COMPANY
Cleveland 6, Ohio

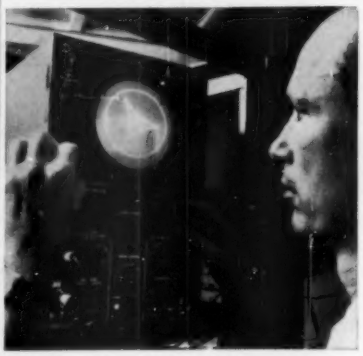
The Nation's largest independent producer of malleable and pearlitic malleable

New Developments

United States, the Azores in the mid-Atlantic on the east, the Arctic Ocean on the north, and the Gulf of Mexico on the south. Thus an aircraft at high altitude can fly from the West Coast of the United States to the Azores without retuning or readjusting the equipment. The pilot could get continuous indication of his position at all times with respect to the ground station.

TRADIC FOR AIRCRAFT

The development of a new-type electronic computer for use in supersonic aircraft was announced recently by the Air



Computer shows answers on scope.

Research and Development Command. Developed by the Bell Telephone Laboratories in coöperation with ARDC's Wright Air Development Center at Dayton, Ohio, the digital computer is expected to eliminate jet aircraft's greatest electronic problems—vacuum-tube failure and heat—by the use of transistors instead of tubes. The computer, known as "Tradic," can do 60,000 additions or subtractions, or 3,000 multiplications or divisions a second.

The laboratory model contains nearly 800 transistors and is believed to be the first all-transistor computer designed for aircraft. Tradic contains, in addition to transistors, nearly 11,000 germanium diodes. These serve as the electronic equivalent of tiny one-way switches. Solid, like transistors, they are capable of operating thousands of times faster than their mechanical counterparts.

PRECISION OPTICS

Northrop Aircraft's Anaheim, Calif., division is now manufacturing ultrahigh-precision glass surfaces on a production basis in a new optical processing center for Air Force and Army Ordnance Corps projects. The company is the first major national-defense contractor in the western United States to install production equipment capable of grinding and polishing glass surfaces accurate to within millionths of an inch.

the Army salutes a "Corporal"!
YES, THE MIGHTY "CORPORAL" is the new pride and joy of the U. S. Army ... and largest guided missile now in production for the Ordnance Corps.
It's a remarkable achievement of both the Jet Propulsion Laboratory of California Institute of Technology, the developer ... and Firestone Tire and Rubber Company, the manufacturer.
WHERE CLARY COMES IN. As we're doing for the "Corporal," we design, test, production-engineer and manufacture mechanical and electro-mechanical precision components.
Our special services include:
• Designing and testing to established specifications and envelope drawings.
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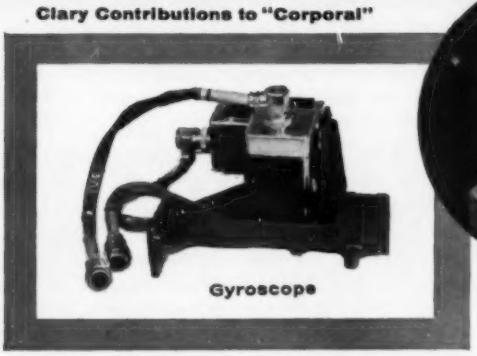
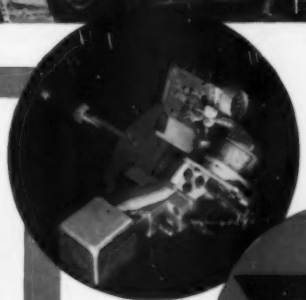
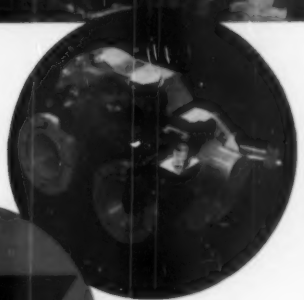
• Manufacturing of precision components to established drawings and specifications.
When MAXIMUM RELIABILITY is a factor in your plans ... call Clary.

Clary Contributions to "Corporal"




Servo Actuator


Propellent Valve

Clary

Automatic Controls Division

CLARY MULTIPLIER CORPORATION
San Gabriel, California

Creator of automatic controls, electronic equipment, aircraft components, business machines

GOVERNMENT FINISH SPECIFICATIONS

and the Parker Products which meet them

This list contains specifications most frequently called for, and some of the Parker Products which meet them. There are Parker Products to meet almost every one of the less frequently used government specifications also. A letter or telephone call to Parker, Detroit, will secure specific information on products to meet government specifications not listed here.

SPECIFICATION	PARKER PRODUCTS
JAN-C-490 (Replaces AXS-1245 and may be superseded by MIL-C-490A)	
Grade I	Bonderite 100, 160, 170, 180
Grade II	
Type 2	Parco Cleaners 341, 350, 371
Type 4	Parco Cleaners 250, 260
Type 5	Parco Cleaners 210, 220
Type 6	Parco Cleaners 100, 101, 110
MIL-10578A (Formerly U.S.A. 3-213)	
Type I (Wash-off)	Parco Cleaner 250
Type II (Wipe-off)	Parco Cleaner 260
MIL-C-5541 (Formerly AN-C-170)	Bonderite 700, 710, 720 (chemical film for aluminum and its alloys)
MIL-C-12968 (ORD) (Supersedes in part U.S.A. 57-0-2)	
Type A—(Formerly U.S.A. 57-0-2, Type I, Class A & A1)	Parco Powder, Parco Lubrite 1 & 2
Type B	
Class 1 (Formerly U. S. A. 57-0-2, Type II, Class B	Parco Compound
Class 2	Parco Compound plus Endurion
MIL-C-16232A (BuORD)	
Type I	Parco Lubrite 1 & 2
Type II	Parco Compound
PA-PD-191	
Grade I	Bonderite 32, 34, 100, 160, 170, 180
Grade II	
Type 2	Parco Cleaners 341, 350, 371
Type 4	Parco Cleaners 250, 260
Type 5	Parco Cleaners 210, 220
Type 6	Parco Cleaners 100, 101, 110
U.S.A. 72-53	Bonderite 32, 34, 100, 160, 170, 180
U.S.A. 57-0-2 [See also MIL-C-12968 (ORD)]	
Type II	
Class A & A1	Parco Lubrite 1 & 2
Class B	Parco Powder—Parco Compound
Class C	Bonderite 100, 160, 170, 180

For information regarding these or other specifications, write

PARKER

RUST PROOF COMPANY

2165 E. Milwaukee Ave., Detroit 11, Mich.

FIRST IN THE FIELD SINCE 1915

RECENT PATENTS

This department on recent military-industrial patents is being published in ORDNANCE *to keep our readers informed of the latest developments in these fields. The data are compiled by Melvin Nord, patent attorney, Detroit, Mich. Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D.C., at 25 cents each.*—THE EDITORS.

COMBUSTION CHAMBER FOR ROCKET

• *U.S. 2,695,496. Issued November 30, 1954, to Robert H. Goddard. Assigned in part to the Daniel and Florence Guggenheim Foundation.*—In this invention a perforated heat-resistant baffle is provided in the path of the injected liquid sprays, thereby diverting the sprays to a direction which does not intersect the path of the outgoing gases. The baffle soon becomes heated and facilitates vaporization of the liquids.

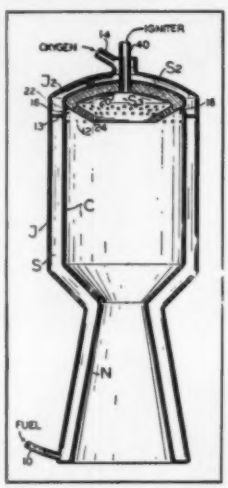


Fig. 1. Rocket chamber.

As shown in Fig. 1, the combustion chamber C and discharge nozzle N are enclosed within a jacket space S. Gasoline or other liquid fuel is supplied through pipe 10 and is injected into the combustion chamber through ports 12 which are directed upwardly and inwardly. Liquid oxygen under pressure enters the jacket space S2 from pipe 14 and passes downwardly and inwardly through ports 16 and a spray which intersects the fuel spray.

The streams of intermingled liquids strike the edges of passages in the compressed carbon baffle, and are diverted upward. The abrupt change in direction of travel causes the liquids to be more intimately mixed, and the high temperature of the baffle causes partial vaporization of the liquids. An igniter 40 starts combustion, and the combustion gases pass down through the central opening in the baffle and out the nozzle.

IGNITER FOR ROCKET PROJECTILES

• *U.S. 2,696,710. Issued December 14, 1954, to Sidney Golden. Assigned to the Secretary of Defense.*—This invention describes an igniter composition which makes it possible to ignite the propellant charge of a rocket projectile uniformly and simultaneously. The composition consists of an intimate mixture of black powder uniformly dispersed in a combustible binding agent such as nitrocellulose or a mixture of nitrocellulose and nitroglycerin.

In this invention a trap rod coated with the ignited composition is surrounded by propellant powder in the form of washers. The amount of igniter material used is therefore very small so that excessive pressures are avoided and the powder charge can be instantaneously and uniformly ignited.

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AND
AUTOINSPECTION
SYSTEMS, CIRCUITS
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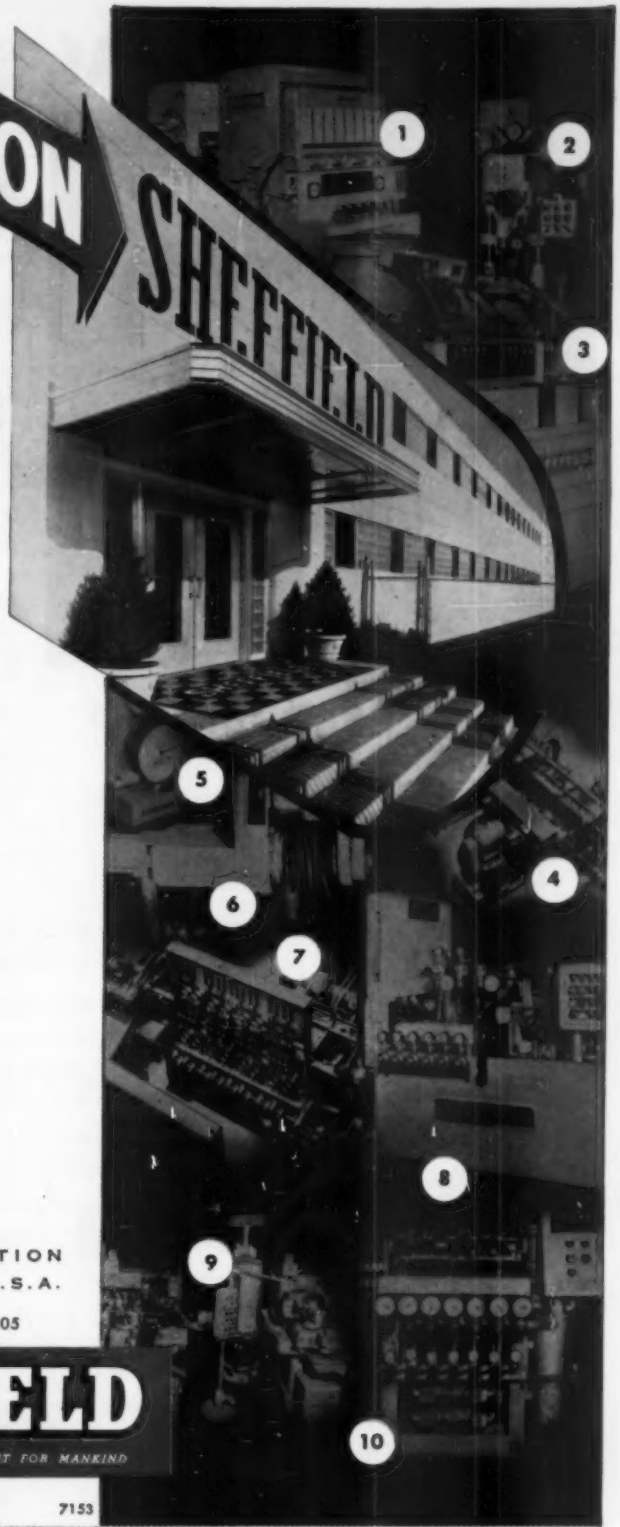
HAVE BEEN OUR
BUSINESS FOR
MORE THAN A
DECADE. IT
WILL PAY YOU
TO CHECK YOUR
NEEDS AGAINST OUR
EXPERIENCE



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9. Controlling bore size of pinion blanks
10. Automatic gaging of crankshaft main bearings

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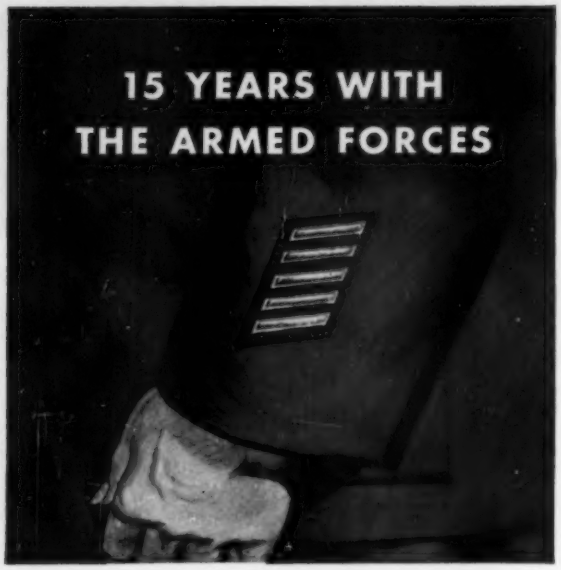

IN RESEARCH, ENGINEERING AND MANUFACTURING

For a decade and a half Pyle-National has engineered and manufactured electrical and electro-mechanical systems and components for the military. Today all of the skills and facilities developed at Pyle-National during this association, are available to meet your problems. The following special product's bulletins are representative of items developed and produced to meet military needs.

U. S. ARMY Type Junction Boxes . . .

submersible, available in various types and sizes. All may be furnished with receptacles.

U. S. NAVY Type Connectors . . .

available in 2 to 18 pole combinations. All contact units are interchangeable and reversible.

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watertight pin & socket and coaxial combinations in 2 to 92 pole. Similar units for Army specifications.

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Pyle-National engineering staff is at your command without obligation. Communicate your problems or requirements to us for immediate attention. Please direct inquiries to:

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SINCE 1897

THE PYLE-NATIONAL COMPANY

Where Quality is Traditional

1371 North Kostner Avenue, Chicago 51, Illinois

Recent Patents

ELECTRIC BLASTING CAP

• *U.S. 2,695,563. Issued November 30, 1954, to Thomas J. Mulqueeny. Assigned to Olin Mathieson Chemical Corporation.*—This invention provides a moistureproof closure for electric blasting caps which is sufficiently rigid to support the electrical firing assembly and which can be readily installed in the cap.

As shown in Figure 2, the case contains the base charge of explosive 2, an initiating charge 3, and an igniting charge 4. A molded plastic plug 5 carries the lead wires 8, which project into the igniting charge where they are bridged by a resistance wire 9. A rubber gasket 10 is held by crimps 11 and 12 in position so as to provide lateral support for the plug, while being itself supported from below by the flange 6 of the plug.

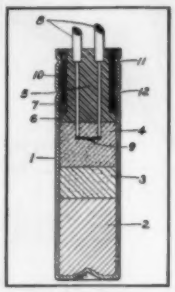

Fig. 2. Blasting cap.

PLASTIC ARMOR PLATE

• *U.S. 2,697,054. Issued December 14, 1954, to Albert G. H. Dietz and Fred E. Mooney. Assigned to the Secretary of the Army.*—This invention provides a laminated plastic armor plate composed of woven fabrics bonded together, which is sufficiently flexible to be worn as clothing. It is claimed to be superior to steel on a weight-for-weight basis in shielding against flying shell fragments.

JET ENGINE OPERATION

• *U.S. 2,696,708. Issued December 14, 1954, to George D. Kittredge. Assigned to Phillips Petroleum Company.*—Carbon deposition in jet engines is minimized by adding to the fuel small amounts of iron pentacarbonyl as a carbon-formation inhibitor. The use of the inhibitor permits increased utilization of aromatics and other hydrocarbons which normally result in considerable carbon deposition in the operation of jet engines. About 0.1 to 0.5 volume per cent of the inhibitor is added to the fuel.

METHOD OF SUBMARINE BLASTING

• *U.S. 2,699,117. Issued January 11, 1955, to Adolphe J. C. La Prairie. Assigned to Canadian Industries Ltd., Montreal, Que.*—This invention provides a method of blasting in underwater locations while avoiding damage to near-by submerged installations such as foundations. The problem is solved simply by providing a stream of air bubbles between the point of blasting and the structure to be protected. Since air is compressible, it damps most of the shock wave.

ROTATIONAL RECORDER

• *U.S. 2,698,215. Issued December 28, 1954, to Joseph A. Peck. Assigned to the Secretary of the Army.*—In drop-testing new bomb designs having tail vanes which rotate the bomb, it is important to determine such characteristics as velocity and r.p.m. of the falling bomb. The invention provides an instrument for measuring r.p.m. It consists of a centrifugal weight which is actuated by the rotation of the bomb in fall and which registers the position of the weight on impact.

SIMULATED DEPTH CHARGE

• *U.S. 2,696,105. Issued December 7, 1954, to George Mackas. Assigned to the Secretary of the Navy.*—In order to design underwater equipment to withstand underwater explosions, it is necessary to study the effects of shock and pressure waves on the equipment. The present invention provides an apparatus for simulating such explosions, utilizing the principle of water hammer. A hammer is caused to strike a piston mounted in a water reservoir which is pressurized with air. The resulting shock wave is similar to that produced by an underwater explosion.

New catapult and arresting gear gets them off and brings them back—safely

Task forces from E. W. Bliss Company's Ordnance Division have been working closely with Navy officials in development, production and servicing of steam catapults and arresting gear.

Some of our men have worked at the prototype stage; some are scattered around the world, supervising installation and maintenance of this equipment aboard U. S. Navy carriers. Still others serve at home, supervising production, or working on steam catapult conversion plans for the large Midway-class carriers.

Because of the size of Bliss' seven U. S. plants and the scope of its facilities, it is able to absorb these and other classified ordnance projects without affecting its role as world's leading builder of presses, rolling mill and special machinery.

BLISS FACILITIES AT A GLANCE

- Seven major manufacturing plants in U. S. totaling more than 1,750,000 sq. ft. of floor space.
- Two licensed Meehanite foundries.
- Two welding shops—both capable of handling extremely large weldments.
- Facilities for both large, heavy parts and for small precision parts . . . from catapults to machine guns, for example.

E. W. Bliss Company, Canton, Ohio

PRESSES, ROLLING MILLS, SPECIAL MACHINERY

CATAPULTS • ARRESTING GEAR • MACHINE GUNS
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Plants at: Canton, Cleveland, Salem and Toledo, Ohio; Detroit and Hastings, Michigan; San Jose, California; E. W. Bliss (England) Ltd., Derby; E. W. Bliss Co. (Paris), France

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If you use bolts and lock washers for fastening assemblies... here's a suggestion for saving time and money. Substitute Reliance Springtites and Sems. You can reduce manual fastening time by ½ and multiply efficiency by 2.

THIS IS WASTE MOTION *THIS IS EFFICIENCY*

Savings result from the one piece design of these Reliance fasteners. By making the lock washer an integral and functional part of the bolt, production workers eliminate the steps of picking up a lock washer, slipping it in place and holding it until the piece is fastened. Production costs drop.

Engineering bulletin S-49 will give you more complete details. Write for a copy and it's yours. No obligation.

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F. W. FOSTER GLEASON, *military historian, ordnance analyst, editor, Washington, D. C.*

DR. JOHN J. O'CONNOR, *educator, author, editor, Washington, D. C.*

F. B. PATRICK, *senior optical engineer, Frankford Arsenal, Philadelphia, Pa.*

BRIG. GEN. THOMAS K. VINCENT, U.S.A., Ret., *artillerist, engineer, author, Washington, D. C.*

CAPT. J. M. P. WRIGHT, U.S.N., Ret., *naval ordnance engineer, logistician, editor, Washington, D. C.*

COL. GRATIAN M. YATSEVITCH, *nuclear engineer, Ordnance Corps, United States Army, Washington, D. C.*

Assignment to Catastrophe. Vol. II—The Fall of France. By Maj. Gen. Sir Edward Spears. New York: A. A. Wyn, Inc. 333 pp. $5.

THIS second volume of General Spears' story ("Prelude to Dunkerque" was reviewed in ORDNANCE for March-April) is not merely a continuation of the record but a realization of all the fears there expressed. Certainly this is the more valuable study of the two, for in it the author shows that he is aware of the political rottenness to which his great personal affection for France had largely blinded him.

Taking up the record at the time of the heroic but terrible evacuation of Dunkerque he unfolds the well-nigh incredible story of the complete lack of plan, communication, improvisation, or initiative of the French forces—especially true of the vitally needed Air Force. Even more stunning was the complete lack of any moral foundation for the French Government or people.

As to the strictly military failure, perhaps his oft-repeated explanation is very near the truth: To the bitter end, the French mind seemed obsessed with the idea that they alone were "the master military race"; therefore, they had nothing to learn, could not improve, and any failure must be the fault of others. Perhaps the ghost of Napoleon was Hitler's greatest aid!

It was but two weeks short of the final collapse that De Gaulle was made Undersecretary of War. Finally threatened with arrest by defeatist Weygand, he was smuggled to England by General Spears—probably the most important piece of work that the latter was able to accomplish in his entire mission.

Another highlight in the tragic story is the offer, by Churchill, of "Franco-British Union," in which prostrate France was to enjoy a full share in the resources and privileges of the still-intact British Empire. Its refusal shows, as nothing else could, the completeness of the mental and moral collapse of the Third Republic.

Despite some quite overdetailed writing and a few points which are explained a bit less than might be desirable, the volume offers some truly fascinating reading. It is of vital import to any American who would correctly evaluate the present and future setup of Europe.—F. W. FOSTER GLEASON.

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Book Reviews

The Influence of Force in Foreign Relations. By Capt. W. D. Puleston, U.S.N. (Ret.). New York: D. Van Nostrand Company. 254 pp. $4.50.

CAPTAIN Puleston, the author of several works on naval history, has boiled down the events of 1917 through 1953 to show that force is of paramount influence in all foreign relations and in his brief recounting of history presents some startling propositions.

History proves that no nation that could not defend itself by force has retained its independence. From this basic proposition the author launches on a whirlwind "run-down" of encounters on the battlefield and at the conference table briefly covering the international scene since World War I.

After defining force as land or sea power supported by air power the author describes the need for close coördination of military and diplomatic officials as an essential for the optimum application of force. In this area Captain Puleston gives his views on our failures in World War II and criticizes outspokenly those he considers at fault.

This Nation has the weapons and the power to use force skillfully to attain its national directives but is inviting eventual disaster by its fallacious theory that a democracy must wait for the enemy's first blow, especially in the face of present-day weapons of massive destruction, before attacking.

The author presents a sensible approach to the foregoing problem that does not entail a preventive war.—J. M. P. WRIGHT.

Grand Inquest. By Telford Taylor. New York: Simon & Schuster, Inc. 359 pp. $4.50.

A COMPLETE story of United States Congressional investigations, starting in 1792 with the drawn-out and never-consummated investigation of Gen. Arthur St. Clair's defeat at the Battle of the Wabash. This book covers the why of Congressional investigations, how these powers are abused, and the dangers which are the product of the domestic conflict, which the author calls the "Cold Civil War."

It is an informative book, written by a brilliant lawyer and Government administrator. Many readers will accept parts of this narrative with reluctance, due perhaps to disagreement with the author's part as prosecutor at the Nuremberg trials, but regardless of personal views the book will give all readers a needed warning of the harm which can come from continuing the misuse of this essential civic institution—the Congressional investigation.—T. K. VINCENT.

Binoculars, Telescopes, and Telescopic Sights. By Truman Henson. New York: Greenberg, Publisher; Toronto, Canada: Ambassador Books, Ltd. 515 pp. $9.50.

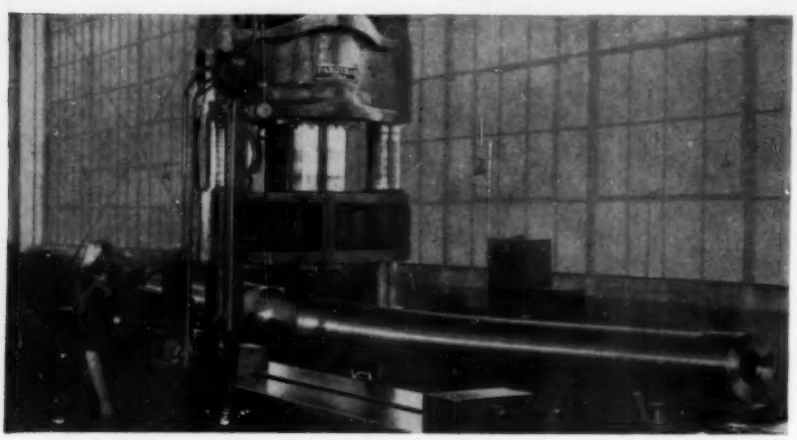
THE author, a successful New York attorney with a sportsman's flair, writes about optical instrumentation with an enthusiasm for his subject which renders this book extremely readable to the layman as well as to the expert in this field.

In a pleasingly informal manner much of the mystery surrounding the design, manufacture, maintenance, and use of binoculars, telescopes, and rifle sights is dispelled by Mr. Henson as he furnishes practical information about the optical and mechanical functions of these instruments.

The semitechnical information contained in the early part of the book forms a valuable background to any one interested in the admirable undertaking of building his own optical instruments.

One type of information not generally available to the layman is provided in the form of numerous official Ordnance Corps photographs of standard items of optical matériel.

The matter of choosing the appropriate type of optical instrumentation to accomplish a specific purpose is also considered by Mr. Henson. Complete chapters of the book are devoted to the establishment of



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Book Reviews

criteria for making such a selection in each of the three categories indicated by the title.

In addition to the advice offered by the author in these chapters, a comprehensive summary of the optical and physical characteristics of some 107 commercially available binoculars, telescopes, and rifle sights is provided for reference as an appendix.—F. B. PATRICK.

Titanium in Industry. By Stanley Abkowitz, John J. Burke, and Ralph H. Hiltz, Jr. New York: D. Van Nostrand Company. 224 pp. $5.

TWO of the authors of this book are on the staff of the Watertown Arsenal Laboratory and the other is secretary of the Metallurgical Advisory Committee on Titanium of the Ordnance Corps. They have been working continuously on titanium problems during the period of the greatest development of the metal, and their intimate personal knowledge of the subject is evident throughout the chapters of the book.

Only eight years ago there was practically no commercial production of titanium metal, and the Bureau of Mines pilot plant produced only two tons in 1948. Since then the metal has undergone unparalleled technological development, and 5,000 tons were produced in 1954, with an estimated need in 1956 of 35,000 tons.

Engineers and designers will find this volume useful as it describes the methods that have been developed for producing the metal, alloying, casting, working, and forming, as well as the physical properties of the various alloys.—GEORGE S. BRADY.

Prisoner's Bluff. By Rolf Magener. New York: E. P. Dutton & Company. 250 pp. $3.75.

THIS story is well-nigh unbelievable but is authenticated and vouched for as the truth. Two Germans, who had been interned in India during the war, escaped with six others and then separated from them and made their way back to Germany, several years later, by way of Burma, Siam, Indo-China, and Japan.

Their reception by their allies, the Japanese, who were unconvinced of their true nationality, and their exchange of status as prisoners in an internment camp for close confinement by their allies, is interesting in the detail in which it is written and the unforeseen difficulties encountered in presenting the truth and getting it accepted.

The remarkable part of the story is the repetition of events which seemed to be based wholly on luck and coincidence in which these two passed time and again through seemingly impenetrable barriers.

Their fantastic adventures are exciting and interesting, and cause one to wonder why more escapes from prison camps are not successful. It looks so easy, and people of all nations seem so gullible!—T. K. VINCENT.

Billions, Blunders and Baloney. By Eugene W. Castle. New York: Devin-Adair Company. 265 pp. $3.50.

MR. Castle invites us to ponder the melancholy thought that our prestige abroad is on a perpendicular downgrade. He asserts that foreigners, with some saving exceptions, don't like us. What is worse, he declares, they don't even respect us.

The decline of American prestige overseas, in Mr. Castle's opinion, has gone hand in hand with the decline of American patriotism at home. He thinks that the American people since 1945 have permitted themselves to be drugged by fears and hesitations and self-misgivings which have corroded the national will. Our one magic, at every critical juncture, he contends, has been to pour out American dollars to buy security with giveaways and worthless propaganda. Mr. Castle's blunt conclusion is that this sort of magic hasn't worked.

The major defect in the book is that Mr. Castle swings at all American overseas civilian activities with a baseball bat. The only alternative would seem to be a return to complete isolationism.—JOHN J. O'CONNOR.

The First and the Last. By Adolf Galland. New York: Henry Holt and Company. 368 pp. $4.95.

WE have had the Rommel Papers covering the German land operations, and here is a companion volume describing the rise and fall of Germany's air forces during the period 1938-1945. The author is a fearless flier, who opposed Hitler and his intuitive strategy. He was no "yes man" to his superior, Hermann Goering, either, which resulted finally in his dismissal from high places in the air hierarchy of Germany.

He started as a captain and rose to the rank of lieutenant general. His adherance to his beliefs and his unhesitating voicing of them led to his ending the war as commander of a jet squadron, the first operational jet squadron in the world. History has proved that he was right and the leaders of Germany wrong.—T. K. VINCENT.

Nuclear Geology. A Symposium on Nuclear Phenomena in the Earth Sciences. Edited by Henry Faul. New York: John Wiley & Sons, Inc. 414 pp. $7.

THIS volume represents a successful effort on the part of Henry Faul of the

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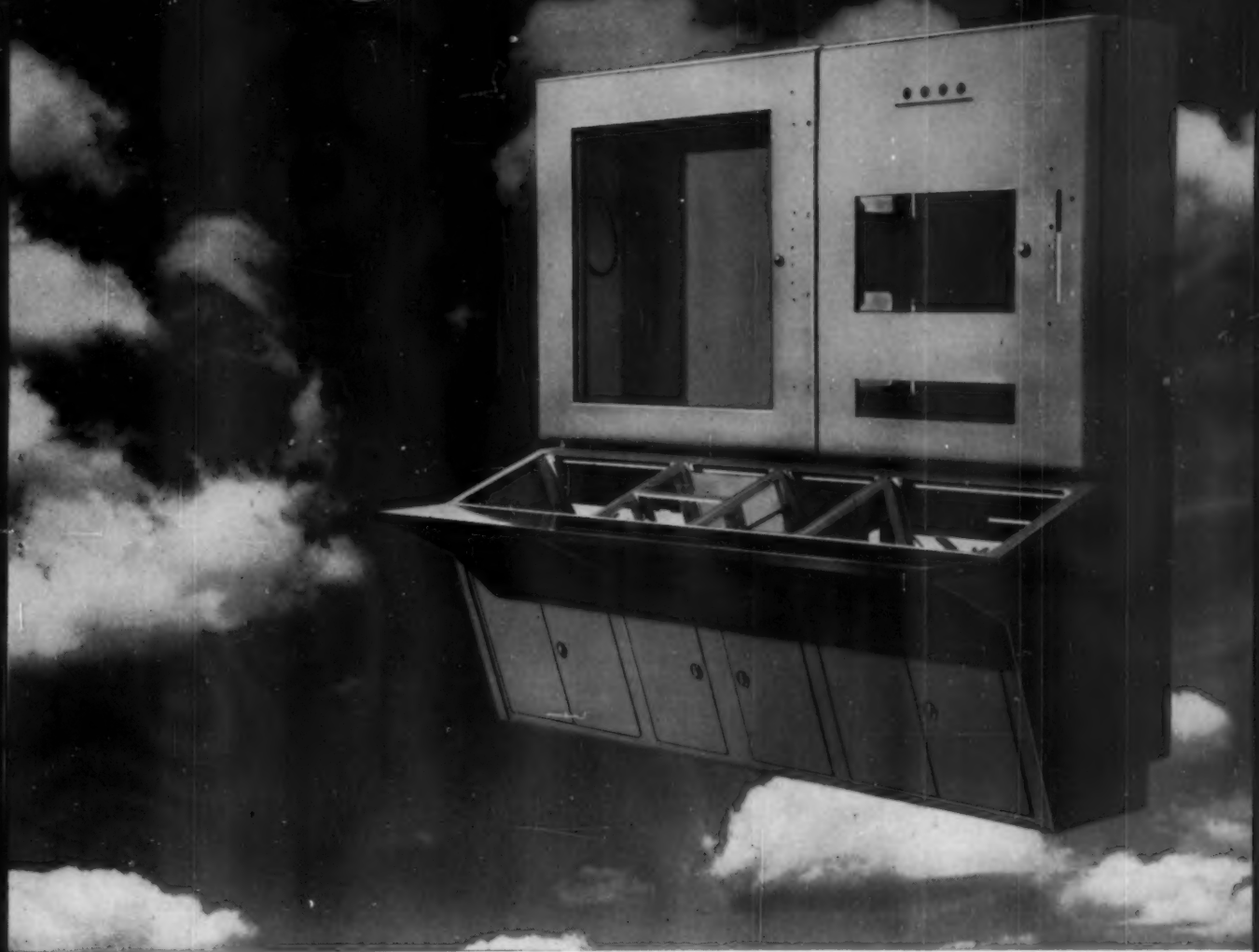

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Book Reviews

U. S. Geological Survey to compile an authoritative text providing a much-needed link between nuclear physics and the pick-and-hand-lens type of geology.

Intended for the professional geologist, it is much too technical for the average reader. However, it does contain a good deal of material which the physicist and the more scholarly layman with scientific interests will find worth reading.

Before undertaking a detailed treatment of specific questions of geological interest, the book provides a brief and useful review of the fundamental considerations and techniques involved in the study of nuclear phenomena in nature.

Subsequent chapters deal with such matters as the occurrence and distribution of radioactive minerals and decomposition products in the earth's crust and the oceans; applications of nuclear methods to geophysical prospecting and mapping; heat from radioactivity; methods for the determination of the absolute age of rocks and mineral substances; and radioactivity and petroleum deposits.—GRATIAN M. YATSEVITCH.

BOOKS RECEIVED

Fatigue of Aluminum. By R. L. Templin. H. W. Gillett Memorial Lecture, 1954. Philadelphia: American Society for Testing Materials. 59 pp. $1.50.

The Gyroscope Applied. By L. I. T. Richardson. New York: Philosophical Library. 384 pp. $15.

Index, Digest, and Annotations to the Uniform Code of Military Justice. By Col. Lee S. Tillotson. Harrisburg: Military Service Publishing Company. 505 pp. $4.

Interpretation of Engineering Data: Some Observations. By Harold F. Dodge. Edward Marburg Lecture, 1954. Philadelphia: American Society for Testing Materials. 36 pp. $1.50.

Marvels of Industrial Science. By Capt. Burr W. Leyson. New York: E. P. Dutton & Company. 189 pp. $3.50.

Modern Physics for the Engineer. Edited by Louis N. Ridenour. New York: McGraw-Hill Book Company. 499 pp. $7.50.

Small Arms of the World. By W. H. B. Smith. Harrisburg: Military Service Publishing Company. 768 pp. $10.00.

Symposium on Effect of Cyclic Heating and Stressing on Metals at Elevated Temperatures. Presented at the 57th Annual Meeting, American Society for Testing Materials, June 17, 1954. Philadelphia: American Society for Testing Materials. 184 pp. $6.

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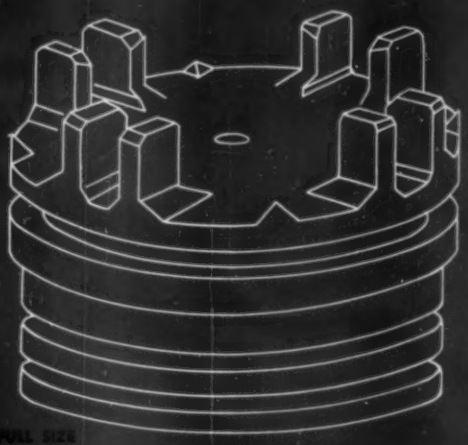

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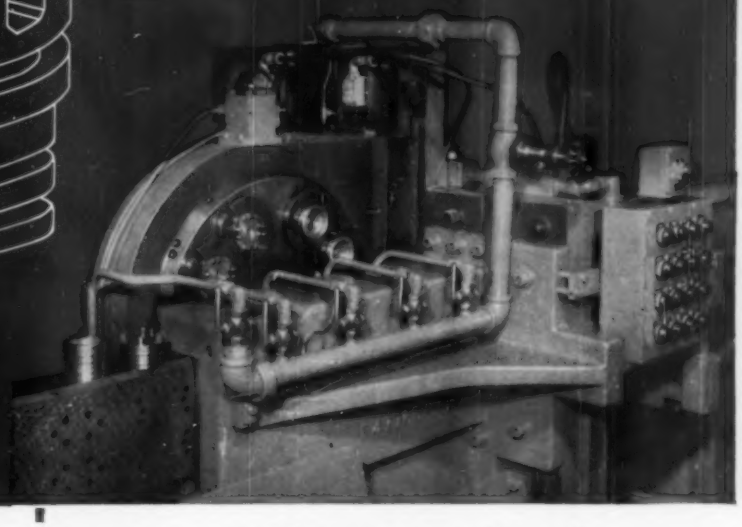

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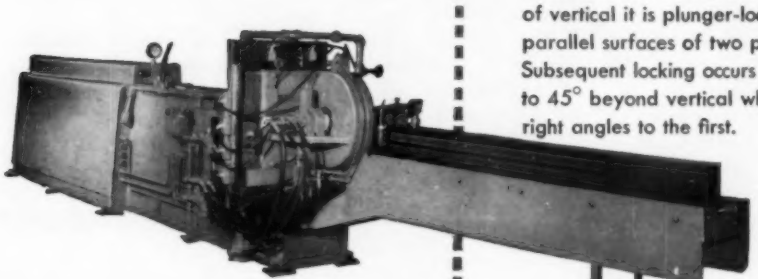

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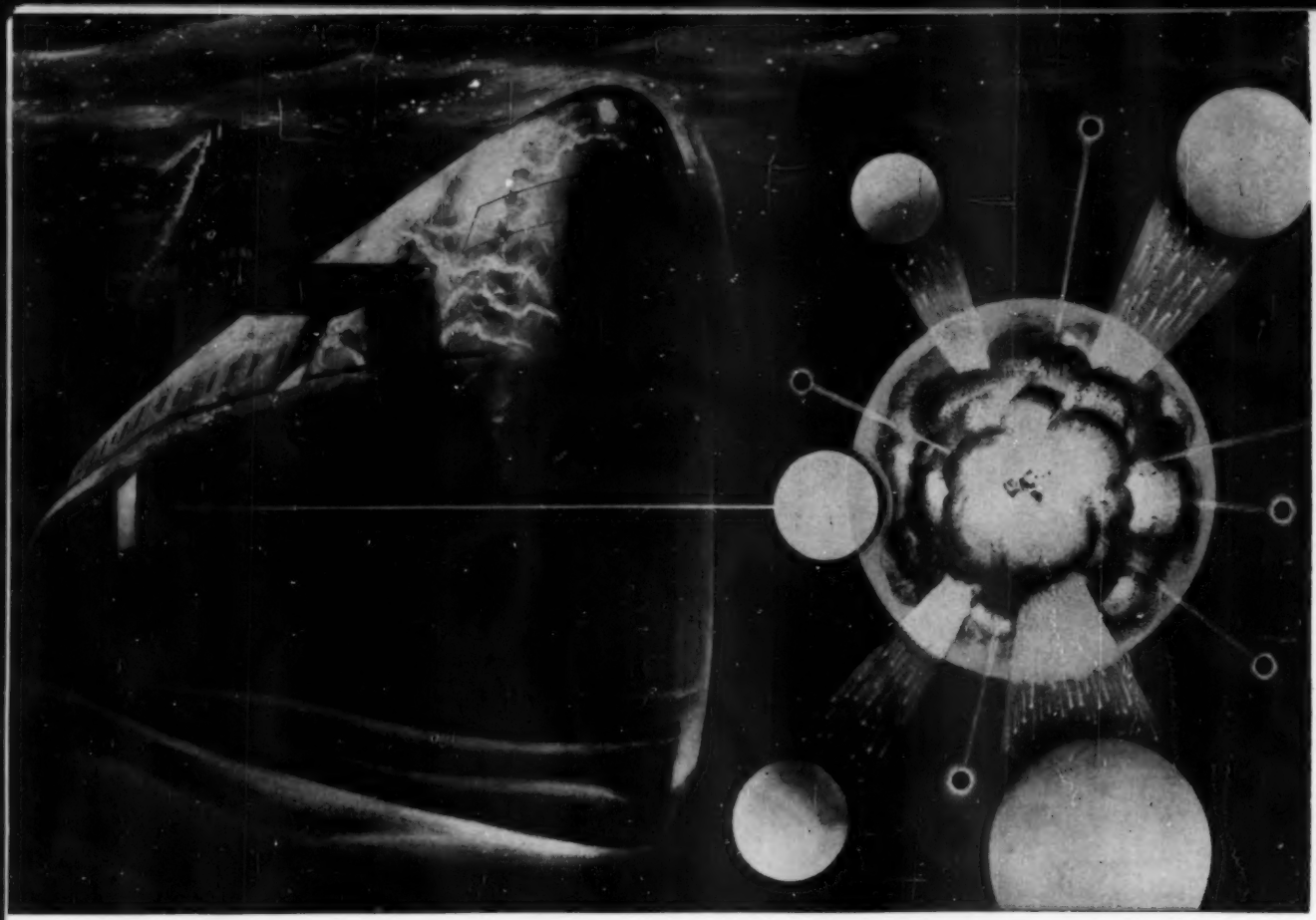

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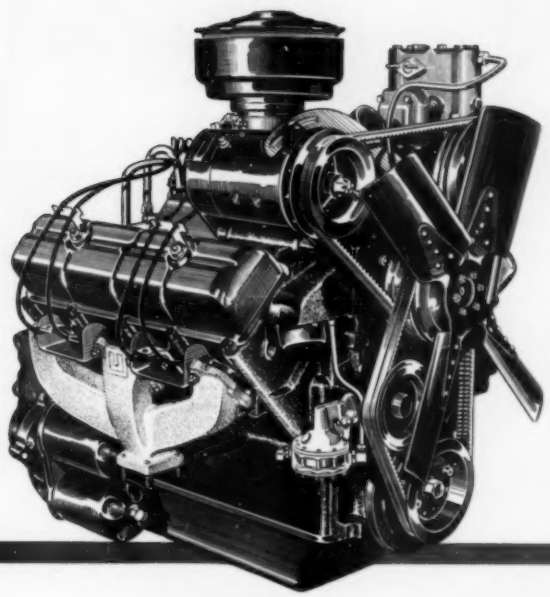

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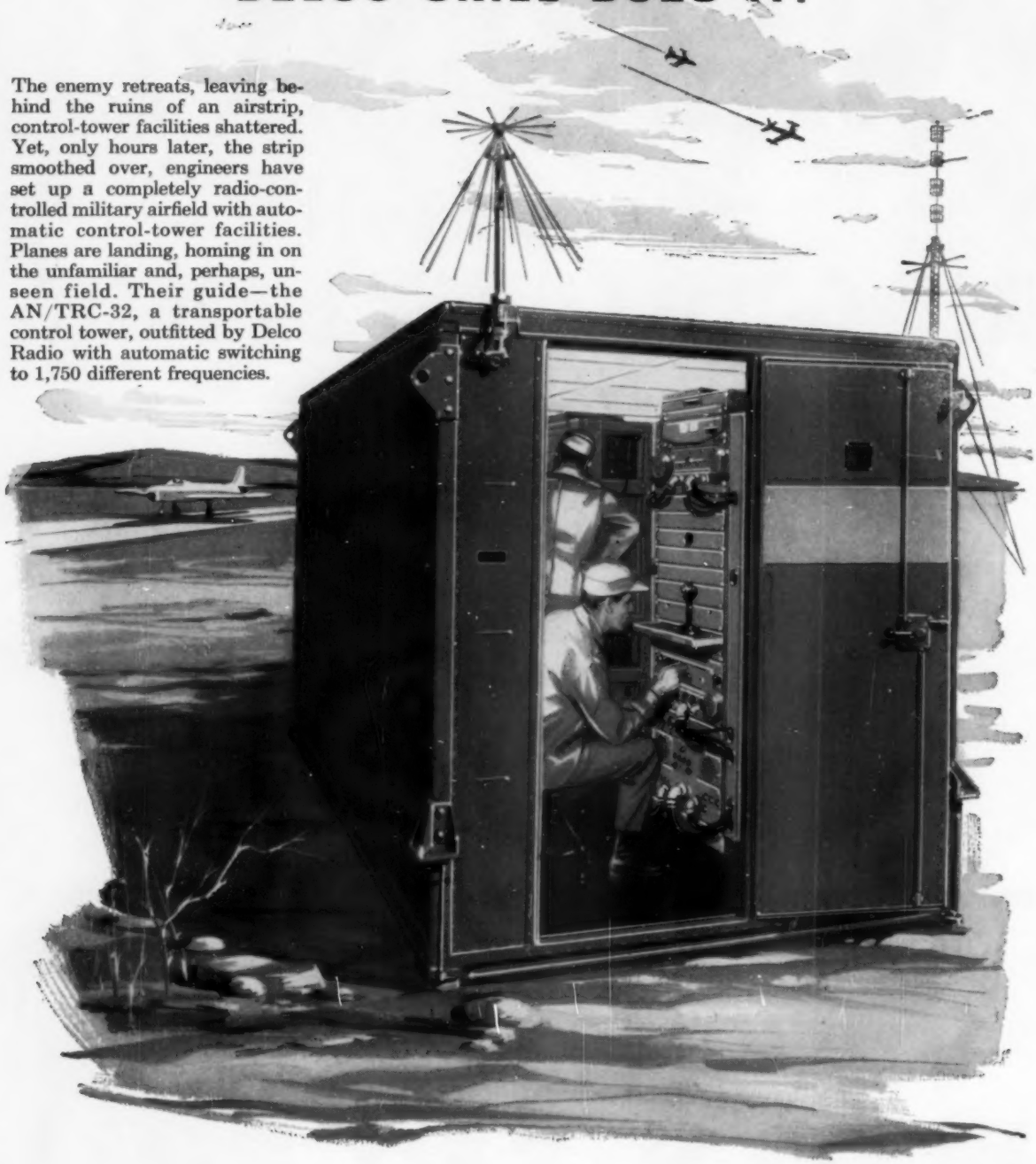

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READY! AMERICA'S FIRST SUPERSONIC SQUADRONS

North American F-100 Super Sabres—now on active operational duty with the 479th Fighter Wing at George Air Force Base, Victorville, California—form America's first Supersonic Squadrons . . . a powerful new defense force unequalled anywhere in the world.

Exemplifying a totally new concept for modern air power, the North American designed and built F-100 Super Sabre flies beyond the speed of sound in level or climbing flight, and is designed to perform equally well in air combat or close-support bombing missions.

This year, to better meet our Air Force needs, North American will produce F-100 Super Sabres at its Columbus, Ohio plant in addition to continued production at Los Angeles.

Constant research and development keep North American foremost in aircraft, rocket engines, guided missiles, electronics and peaceful applications of atomic energy.

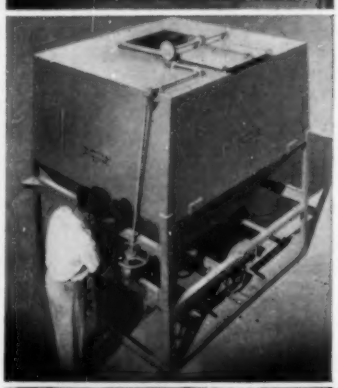
ENGINEERING AHEAD FOR A BETTER TOMORROW

NORTH AMERICAN AVIATION, INC.

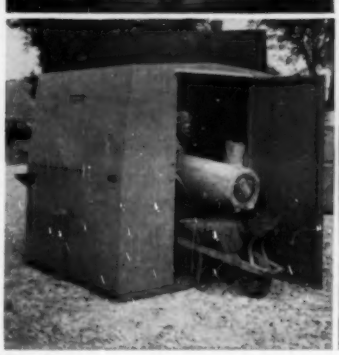
Briefly, this ad illustrates why DEMPSTER-DUMPSTER SYSTEM

Container at right has cast iron bottom and inside walls are lined with fire brick. It handles hot skim off aluminum.

This Tilt Type Container was the result of a cost-cutting idea whereby a high temperature dusty product would be handled by a plant's Dempster-Dumpster. Container has cooling fins, counter-balanced hinged lid with 3-way locking device, 16" sliding gate valve and two sight-glass inspection openings.



Here is a Hopper Type Container with a top door for filling and two bottom discharge doors operated by rack and pinion. Another case where the Dempster-Dumpster System was applied to an additional problem to further reduce costs.



Container at right is just one of several different types we have designed to handle equipment, materials, packages, parcels, etc.

IN A NORMAL INSTALLATION the Dempster-Dumpster System is purchased by a plant because of its proved record for handling bulk materials at tremendous savings. This normal installation usually includes one truck mounted Dempster-Dumpster and any number of standard containers designed to meet the various requirements within the plant. In some cases, containers number 40 to 50. These containers can range in capacity up to 21 cu. yds., with all containers served by the one Dempster-Dumpster.

In the great majority of cases this basic installation is just a starter. Management men, constantly looking for lower operating costs, find numerous and amazing extra savings in the Dempster-Dumpster System. Once in service, transporting developments of every description come to light that supplement the original functions of the equipment. Your own men find easier, quicker and additional cost saving ideas for its use. Many even overshadow the original savings and the equipment becomes more and more indispensable.

Look over just a few of the "Special" containers illustrated in this ad. They are all the result of rough ideas that originated with the men in plants after a basic installation, then developed by our engineers. All ideas were stimulated by the powerful Dempster-Dumpster and its flexibility in picking up, hauling, setting down or dumping anything that needs transporting, at lower cost.

One man, the driver, and a few simple hydraulic controls in the cab of a Dempster-Dumpster, will become indispensable in your plant. It is just that in hundreds of plants of every description throughout the nation. Let one of our representatives give you details of installations. Manufactured exclusively by Dempster Brothers, Inc.

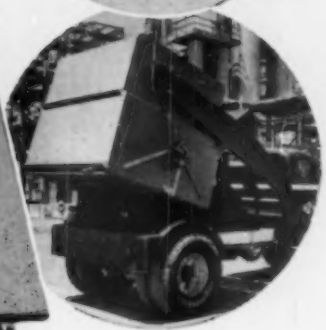
Above container is built with cast iron liner. The holes in outer wall are for cooling.

Here is one of several special drop bottom type containers equipped with coupiers and ball bearing trucks for operation in train on rails.

THE DEMPSTER DUMP-STER SYSTEM

DEMPSTER BROTHERS

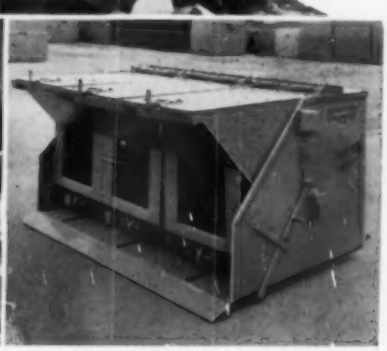
so many plants find the indispensable...



Two photos above show how all containers, regardless of design, are picked up and hauled. At destination materials are dumped from drop bottom containers as shown at left . . . from Tilt and Skip Type Containers by tilting. Any load, of course, may be set down intact.

This is a special adaptation whereby waste zinc slurry is pumped into two containers, which serve as settling tanks, enabling majority of the water to be decanted before sludge is transported and dumped at waste basin.

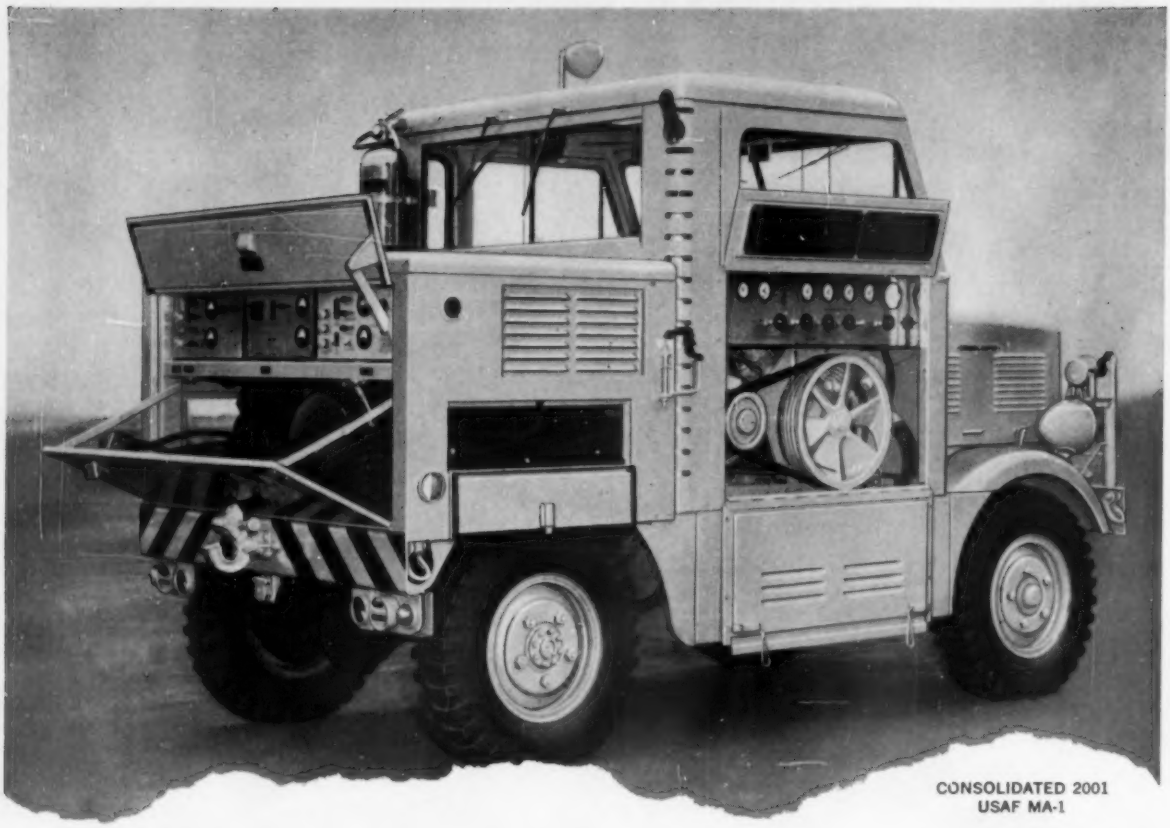
Tank Type Containers are available with or without casters in steel, aluminum, stainless steel, etc. Capacity ranges up to 1,200 gal. They may be lined with rubber, lead, highly resistance coatings, etc.



This is a master container with three 2 cu. yd. insert containers. Each insert container is provided with casters, counter-balanced spring-hinged lid for loading and dumping.

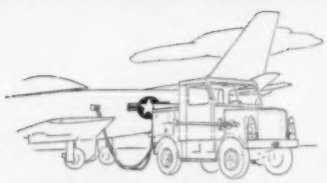
955 Shea Bldg., Knoxville 17, Tennessee

THIS IS



CONSOLIDATED 2001
USAF MA-1

GROUND SUPPORT !



To meet the vital jet age needs of ground support, Consolidated has devoted its fullest resources developing both single and multi-purpose units . . . proven efficient . . and now in active service. Typical of these units is the Consolidated Model 2001 (U.S.A.F. MA-1). This highly compact self-propelled vehicle combines in a single unit all requirements for towing, testing, servicing and starting jet aircraft.

It provides

- **A.C. POWER . . . 30 KVA, 400 cycles, 3 phase and 10 KW 1 phase, close regulated.**
- **D.C. POWER . . . 28.5 volts, up to 2250 AMP. For Split or single bus start and servicing.**
- **COMPRESSOR . . . Air supply up to 3500 psi, 13.5 CFM, 1,000 cu. in. reservoir.**
- **TOWING . . . All-wheel drive vehicle with mechanical or torque converter transmission, as desired.**

IN ACTIVE USE WITH U.S. AIR FORCE, NAVY AND MARINE UNITS . . . Other models of single and multi-purpose ground support equipment are available with any combinations of . . . AC and DC power . . . high pressure air, hydraulics, and low pressure air . . refrigeration and heating.

CONSOLIDATED'S resourcefulness in solving the most challenging problems in the design and manufacture of ground support equipment attests to its ability to develop specialized units to fit your individual needs.

CONSOLIDATED
DIESEL ELECTRIC CORPORATION

STAMFORD, CONN. BRANCHES · DALLAS, TEX DAYTON, OHIO SANTA ANA, CAL WASHINGTON, D. C.

helping hands . . . united yet diversified

Today, it takes more than a better mousetrap for the world to beat a well worn path leading to your door.

Today, it takes the helping hands of diversified industries united under one progressive management.

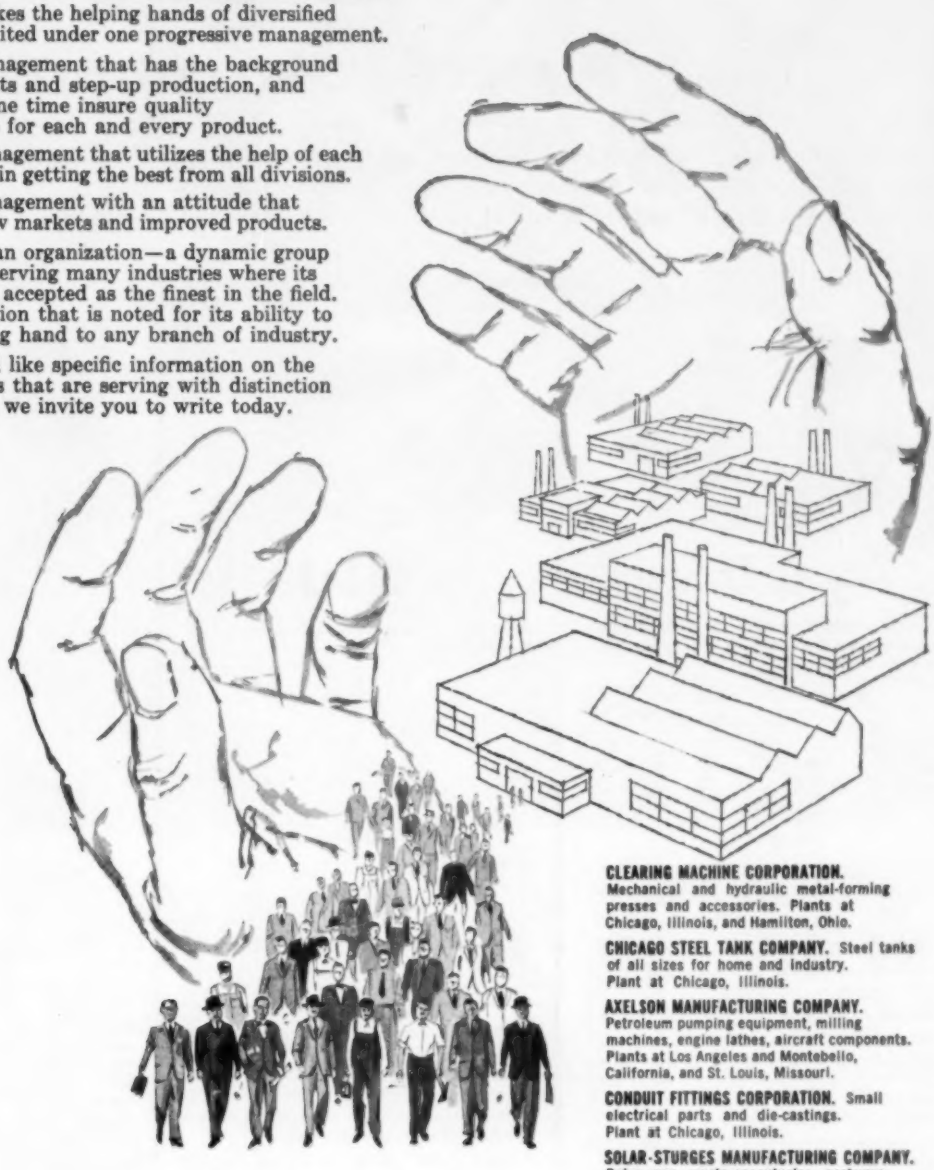
. . . A management that has the background to cut costs and step-up production, and at the same time insure quality leadership for each and every product.

. . . A management that utilizes the help of each division—in getting the best from all divisions.

. . . A management with an attitude that fosters new markets and improved products.

USI is such an organization—a dynamic group of divisions serving many industries where its products are accepted as the finest in the field. An organization that is noted for its ability to give a helping hand to any branch of industry.

If you would like specific information on the USI products that are serving with distinction in *your* field, we invite you to write today.



CLEARING MACHINE CORPORATION. Mechanical and hydraulic metal-forming presses and accessories. Plants at Chicago, Illinois, and Hamilton, Ohio.

CHICAGO STEEL TANK COMPANY. Steel tanks of all sizes for home and industry. Plant at Chicago, Illinois.

AXELSON MANUFACTURING COMPANY. Petroleum pumping equipment, milling machines, engine lathes, aircraft components. Plants at Los Angeles and Montebello, California, and St. Louis, Missouri.

CONDUIT FITTINGS CORPORATION. Small electrical parts and die-castings. Plant at Chicago, Illinois.

SOLAR-STURGES MANUFACTURING COMPANY. Dairy cans, waste receptacles, cookware. Plant at Melrose Park, Illinois.

ORDNANCE DIVISION. Modification and processing of armored vehicles of all types. Plant at Hegewisch, Illinois. Also operates ordnance plant at Rockford, Illinois.

KOPPEL INCORPORATED. Distributors of leading agricultural and industrial machinery and equipment in the Philippine Islands.

PRESSED STEEL CAR CO., DIV. Exporters of railway equipment and industrial equipment and machinery to all parts of the world.

U. S. INDUSTRIES, Inc.

270 Park Avenue, New York, New York

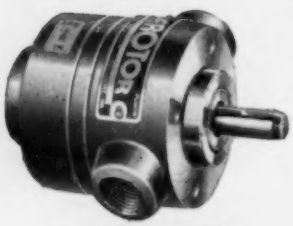
USI

"A FAMILY OF MEN & MACHINES UNITED TO SERVE INDUSTRY BETTER"

THAT FINE LINE OF PERFECTION

There's a GEROTOR HYDRAULIC PUMP *to meet your requirements!*

The GEROTOR line of precision engineered hydraulic pumps is designed to fill the requirements of the majority of hydraulic equipment users. The three standard GEROTOR models cover a range of g.p.m. delivery from .4 g.p.m. to 40 g.p.m. Check the selection data for the pump to fill your needs.



TYPE QDB

Gerotor's NEW QDB series of small capacity pumps . . . the last word in precision engineering.

TYPE	DELIVERY G.P.M. — 1800 R.P.M. DISCHARGE PRESSURE P.S.I.				
	0	250	500	750	1000
QDB .4	.42	.40	.38	.35	.31
QDB .75	.84	.80	.78	.73	.66
QDB 1.5	1.67	1.62	1.57	1.50	1.42

Selection Data

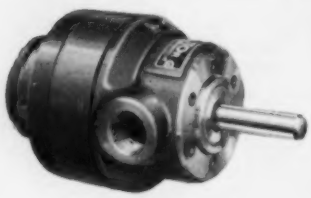
TYPE	HORSEPOWER REQUIRED — 1800 R.P.M. DISCHARGE PRESSURE P.S.I.				
	0	250	500	750	1000
QDB .4	.08	.16	.24	.33	.41
QDB .75	.13	.27	.41	.56	.71
QDB 1.5	.16	.42	.70	1.00	1.28

PRESSURE—Maximum continuous operating pressure is 1000 p.s.i.

SPEED—Standard design speed is 1800 r.p.m. Specific recommendations are made for applications at other speeds.

ROTATION—Standard rotation is clockwise facing shaft end. Counter-clockwise rotation is available.

OIL—Hydraulic oils with viscosity of approximately 300 s.s.u. at 100° F. are recommended.



TYPE QDH

The QDH . . . popular intermediate size of the Gerotor line

TYPE	DELIVERY — G.P.M. AT 1200 R.P.M. DISCHARGE PRESSURE P.S.I.						
	0	250	500	750	1000	1200	1500
QDH 3	3.3	3.2	3.1	3.0	2.9	2.7	2.5
QDH 5	5.6	5.4	5.3	5.2	5.1	4.8	4.4
QDH 8	8.6	8.5	8.4	8.3	8.2	8.1	7.8
QDH 12	12.9	12.8	12.7	12.5	12.3	12.2	11.8

Selection Data

TYPE	HORSEPOWER REQUIRED AT 1200 R.P.M. DISCHARGE PRESSURE P.S.I.						
	0	250	500	750	1000	1200	1500
QDH 3	.25	.7	1.2	1.6	2.1	2.5	3.4
QDH 5	.33	1.1	1.8	2.5	3.2	3.7	4.6
QDH 8	.4	1.5	2.7	4.2	5.4	6.3	7.9
QDH 12	.5	2.3	4.2	6.1	8.0	9.6	11.7

PRESSURE—Maximum continuous operating pressure is 1200 p.s.i., maximum intermittent 1500 p.s.i.

SPEED—Standard design speed is 1200 r.p.m. Specific recommendations are made for applications at other speeds.

ROTATION—Standard rotation is clockwise facing shaft end. Counter-clockwise rotation is also available.

OIL—Hydraulic oils with viscosity of approximately 300 s.s.u. at 100° F. are recommended.

TYPE O

Gerotor Series O . . . when larger capacities are needed

TYPE	DELIVERY — G.P.M. AT 1200 R.P.M. DISCHARGE PRESSURE P.S.I.				
	0	250	500	750	1000
0-20	20.0	19.5	18.8	18.0	17.2
0-25	25.0	24.5	24.0	23.2	22.2
0-30	31.2	31.0	30.5	29.8	29.0
0-40	43.0	42.5	42.0	41.5	40.0

Selection Data

TYPE	HORSEPOWER REQUIRED AT 1200 R.P.M. DISCHARGE PRESSURE P.S.I.				
	0	250	500	750	1000
0-20	1.0	4.0	7.2	10.5	13.5
0-25	1.5	5.0	8.6	12.0	15.6
0-30	2.0	6.5	10.9	15.5	19.5
0-40	3.0	9.0	15.0	21.0	27.5

PRESSURE—Maximum continuous operating pressure is 1000 p.s.i., except type 0-40, which is recommended for only intermittent duty at 1000 p.s.i.

SPEED—Standard design speed is 1200 r.p.m. Specific recommendations are made for applications at other speeds.

ROTATION—Standard rotation is clockwise facing shaft end. Counter-clockwise rotation is available.

OIL—Hydraulic oils with viscosity of approximately 300 s.s.u. at 100° F. are recommended.

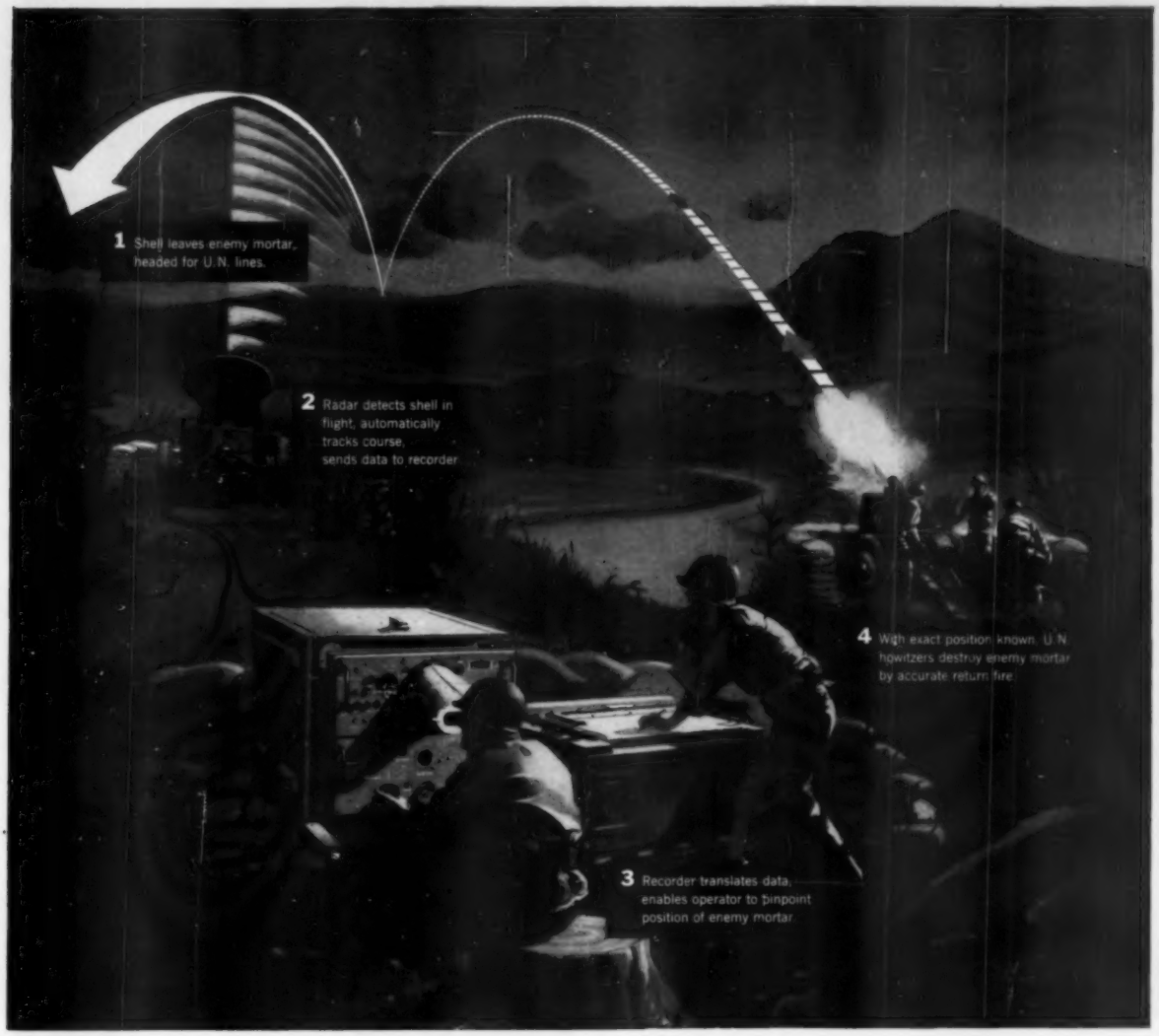
Whatever your needs in hydraulic pumps . . . consult the GEROTOR engineers. Write for FREE literature and information, no obligation, of course.

GEROTOR MAY CORPORATION
1519 Maryland Ave., Baltimore 3, Md.

GEROTOR

HYDRAULIC PUMPS — HYDRAULIC MOTORS

Pneumatic Bin Evacuators — Precision Contract Manufacturing


1 Shell leaves enemy mortar, headed for U.N. lines.
2 Radar detects shell in flight, automatically tracks course, sends data to recorder
3 Recorder translates data, enables operator to pinpoint position of enemy mortar
4 With exact position known, U.N. howitzers destroy enemy mortar by accurate return fire

ENEMIES' MORTARS LOCATED BY RADAR

Army Used Device Against Reds in Korea, NY TIMES, DEC. 12, 1954

THE STORY BEHIND THE STORY:

■ "Hundreds of soldiers now returned safely from Korea literally owe their lives to the extreme accuracy and speed of the new counter-mortar system." This good news was revealed by the Signal Corps in December when the public first learned of the existence of the MPQ-10 Mortar Locator, one of the Army's best kept secrets.

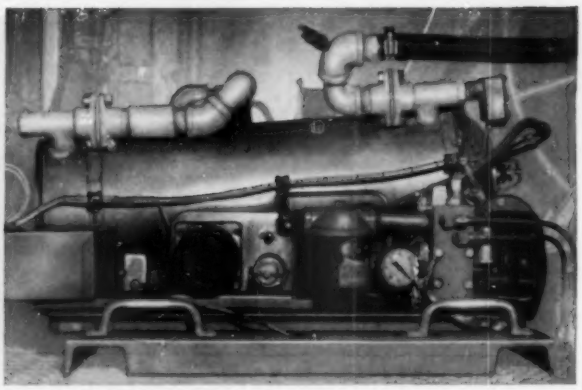
■ How could a carefully concealed enemy mortar be located and destroyed after just one or two shells had been fired? And how could such devastating accuracy be repeated over and over again—no matter how often the enemy relocated his mortars? These were important questions in Korea.

■ Actually, the uncanny efficiency of the MPQ-10 Mortar Locator was due to the joint efforts of the Army Signal Corps and Sperry engineers. Working together, they developed a new portable radar system for use at the front lines. How does it work? An automatic radar tracker detects and "locks on" the path of enemy mortar shells. In effect, it traces each shell back through its trajectory and reveals the enemy position. This information is then relayed to an artillery fire direction center which directs a return barrage against the enemy mortar in a matter of minutes.

■ Delivering this Mortar Locator to the troops is another example of Sperry engineering and production solving a problem to meet a critical need. Today, in the air, at sea, as well as on land, Sperry is helping extend our nation's capabilities with instruments, controls and systems for all branches of the military as well as for important segments of industry.

SPERRY GYROSCOPE COMPANY

DIVISION OF THE SPERRY CORPORATION • GREAT NECK, N. Y.



TYPE 0-6 CRASH TRUCK plus JANITROL LIQUID HEATER equals

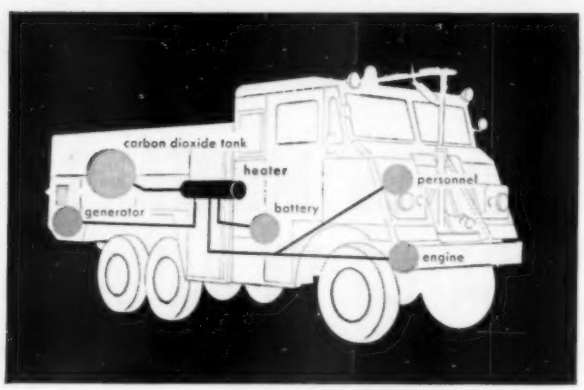
WINTERIZATION TO 65° BELOW ZERO

It takes just fifteen minutes for two men to install and connect, or disconnect and remove the Janitrol Liquid Heater equipped "winterization kit" in the Air Forces new Type 0-6 Cardox Crash Truck.

Cardox engineers took full advantage of Janitrol unit design accessibility . . . added a coolant pump, hand bypass pump, electrical over-ride connections, and an aluminum channel-iron skid base to come up with the ultimate in changeover speed. Just six quick-disconnect couplings tie coolant flow—electric supply—and fuel supply to the permanently installed winterization system within the truck. Operating controls are installed in the truck cab.

The Janitrol heater provides 90,000 Btu/hr for engine block, engine pan, battery box, radiator, cab and body, defrosting, a motor generator set, and the Cardox pressure vessel heating. Complete insurance against winter operating failures caused by freeze-ups!

Look into Janitrol Liquid Heaters' long record of dependability under all conditions—and you'll specify "Janitrol" for vehicle heat wherever and whenever needed.



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Janitrol

AIRCRAFT-AUTOMOTIVE DIVISION, SURFACE COMBUSTION CORP., COLUMBUS 16, OHIO

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For information on the advances in professional, scientific and literary knowledge in the Navy and related services and professions . . .

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The PROCEEDINGS carries the world between its covers. Institute members and PROCEEDINGS contributors span the seven seas and all of the lands bounded by those seas. Every major advance in the maritime picture is factually and interestingly reported in the PROCEEDINGS. Everyone interested in the Navy should be a member of the UNITED STATES NAVAL INSTITUTE and regularly read the PROCEEDINGS. Here are some of the articles that appeared in PROCEEDINGS within the last twelve months:

"*War and Winter in the North Atlantic*" by Rear Admiral Frederick J. Nelson, USN (Ret.)

"*Islam, Force for East or West?*" by Captain Russell S. Hibbs, USMC

"*Catapults Come of Age*" by Lieutenant Dorothy L. Small, USNR

"*Salvo—Splash*" by Colonel Donald M. Weller, USMC

"*The River War in Indochina*" by Robert McClintock, US Ambassador to Cambodia

"*German Naval Strategy Across Two Wars*" by Vice Admiral Friedrich Ruge, formerly of the German Navy

"*Japanese Naval Air Operations in the Philippines Invasion*" by Brigadier General Koichi Shimada, Japan Air Defense Force

"*Sweden's Armed Neutrality*" by William H. Hessler

"*Pentagon Reorganization: Phase Three*" by John R. Probert

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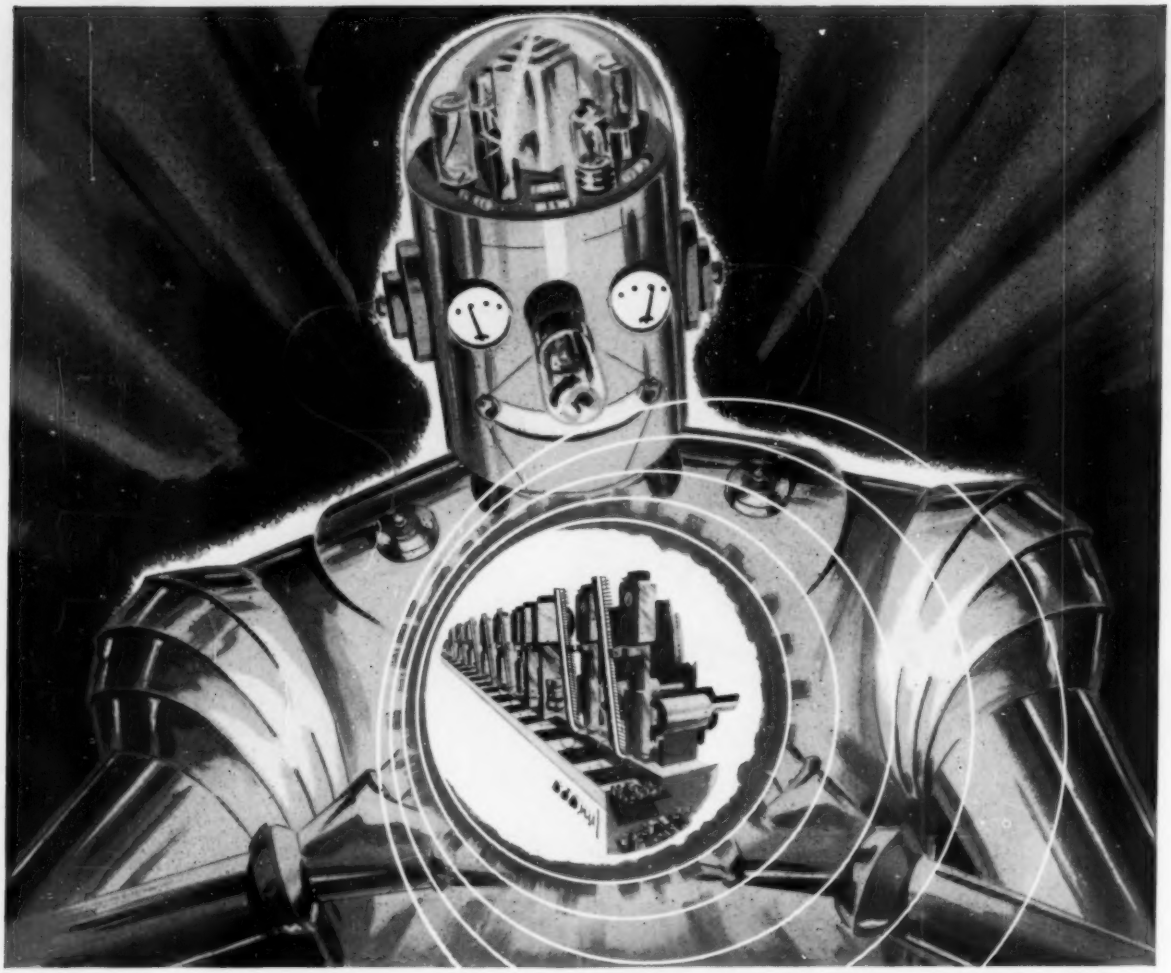

Everybody *talks* about AUTOMATION...

Admiral. *has it!*

Automation, at Admiral, is an established fact . . . fully proved-in-practice on a wholly automatic assembly line which for many months has been producing electronic assemblies at rates up to 5,000 per day.

The importance of automation to the production of military electronic equipment cannot be over-stated. For one thing, automation substantially reduces unit costs . . . makes expendable items less expensive. Automation also guards against error and helps to maintain unwavering quality standards.

The automation equipment now in use was designed, developed and produced by Admiral's own engineering staff. Facilities are available for the production of electronic or electromechanical units in virtually any quantity, large or small. Address inquiries to:

Admiral Corporation

Government Laboratories Division, Chicago 47, Illinois

NOTE: COLOR SOUND FILM on Automation available for showing to technical or business groups. Film runs 9 minutes. Address requests to Public Relations Director, Admiral Corporation, Chicago 47, Ill.

Look to Admiral for

- RESEARCH
- DEVELOPMENT
- PRODUCTION

in the fields of:

COMMUNICATIONS, UHF and VHF, air-borne and ground.
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RADIAC • MISSILE GUIDANCE
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TEST EQUIPMENT

Send for Brochure . . . complete digest of Admiral's experience, equipment and facilities.

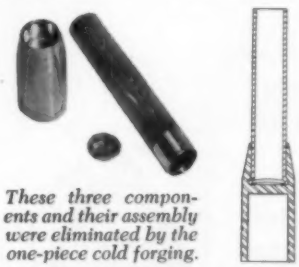
ENGINEERS! The wide scope of work in progress at Admiral creates challenging opportunities in the field of your choice. Write to Director of Engineering, Admiral Corporation, Chicago 47, Ill.

HUNTER DOUGLAS ONE-PIECE COLD FORGINGS

replace 3 piece unit, eliminate assembly, solve gas leakage problems!

A typical example of how Hunter Douglas cold forgings simplify everyday design problems

A most critical requirement in the production of an ordnance component was a perfect seal against the escape of high pressure gases. Fabrication by conventional procedures involved the assembly of three separate pieces—a screw machine part turned from bar stock and bored from each end; a separate sleeve machined from tubing, and a stamped Welsh plug. The three parts were unitized by expanding the Welsh plug within the sleeve, forcing walls into a machined groove within the head.



These three components and their assembly were eliminated by the one-piece cold forging.

To simplify the design, insure leak-proof construction and eliminate costly machining and assembly time, Hunter Douglas engineers suggested a cold forging from HD-11-T6, a high strength aluminum alloy.

All internal and external diameters of the cold forged component are now formed in a single, instantaneous press operation. No joints exist to cause leakage, consequently rejects are negligible. The cold forging, being highly stressed, easily withstands bursting pressures of 5500 psi without distortion. With its remarkable simplification in design, the cold forging requires fewer machining operations, thus saving both time and unnecessary metal waste.

Hunter Douglas Cold Forgings can be mass-produced in any required numbers and to cover a tremendous range of design requirements. If your components require *walls of zero draft, high physical properties, employ tubular shapes with or without a closed end, and must meet close dimensional tolerances,* HUNTER DOUGLAS COLD FORGINGS may provide the answer. Our engineers will give you a prompt analysis upon submission of a blueprint or sample part.

Hunter Douglas Cold Forgings cover a multitude of needs. Note wide variation in part geometry. Many complex designs formerly considered impossible to produce by cold forging now respond to new techniques developed at Hunter Douglas.

DESIGNERS:
If you want to know more about Hunter Douglas Cold Forgings write on your company letterhead for this free 40 page book, now on the press!

Hunter Douglas HD Corporation

HUNTER DOUGLAS CORPORATION • DEPT. O-5 RIVERSIDE, CALIFORNIA TELEPHONE OVerland 3-3030

"Peiping

an arrogant, contemptuous regime of hardcore international Communists..."

"I am often asked why the U. S. Government is firmly opposed to recognition of the Chinese Communists and giving them a seat in the United Nations. We are confronted in Peiping with an arrogant, contemptuous regime of hardcore international Communists who have played a gangster role in their relations with us and other countries . . . they have thrown our citizens into jail without trial, they have tortured and brain washed our prisoners of war, they have blackmailed our businessmen, they have confiscated our properties. They respect no law — divine, international or domestic, unless it suits their purposes to do so. They speak not for the great Chinese people and nation but for international Communism."

WALTER S. ROBERTSON
Assistant Secretary of State

To recognize Red China would be to condone the very evils we abhor. It would mean abandoning all moral principles, and destroying the hopes of oppressed peoples everywhere. We must not put the seal of approval on tyranny.

W. B. Stewart
President

DUTY HONOR COUNTRY
LABOR BUSINESS GOVERNMENT

The GRAY Manufacturing Company, Hartford 1, Conn.
Audograph and PhonAudograph "Pushbutton Dictation" Equipment

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naval fire-control

. . . AND FORD INSTRUMENT COMPANY

Firing at a target many miles away from a pitching and rolling ship, steaming at full speed, requires rapid, complicated computations. Special computers and drives must do this job.

Throughout the past forty years, engineers of Ford Instrument Company have been specialists in this field – from their design of the earliest Rangekeeper in World War I to the latest great Naval electro-mechanical-electronic computers. As in their missile and aircraft instruments, their nuclear controls and weapon systems, the criteria of dependability and precision are the characteristics of Ford designed and manufactured computers and controls.

Ever since 1915, when Hannibal C. Ford built the first gunfire computers for the U. S. Navy, Ford Instrument Company has been a leader in applying the science of automatic control to American defense and peacetime industry. For more information, write for free illustrated brochure.

46

FORD INSTRUMENT COMPANY

DIVISION OF THE SPERRY CORPORATION

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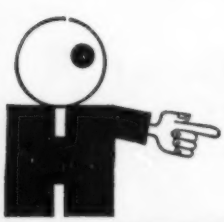

Keep your eye on the forward march at Hoffman. Write for technical bulletins describing the above systems—and for full details on how we can make your problems our responsibility.

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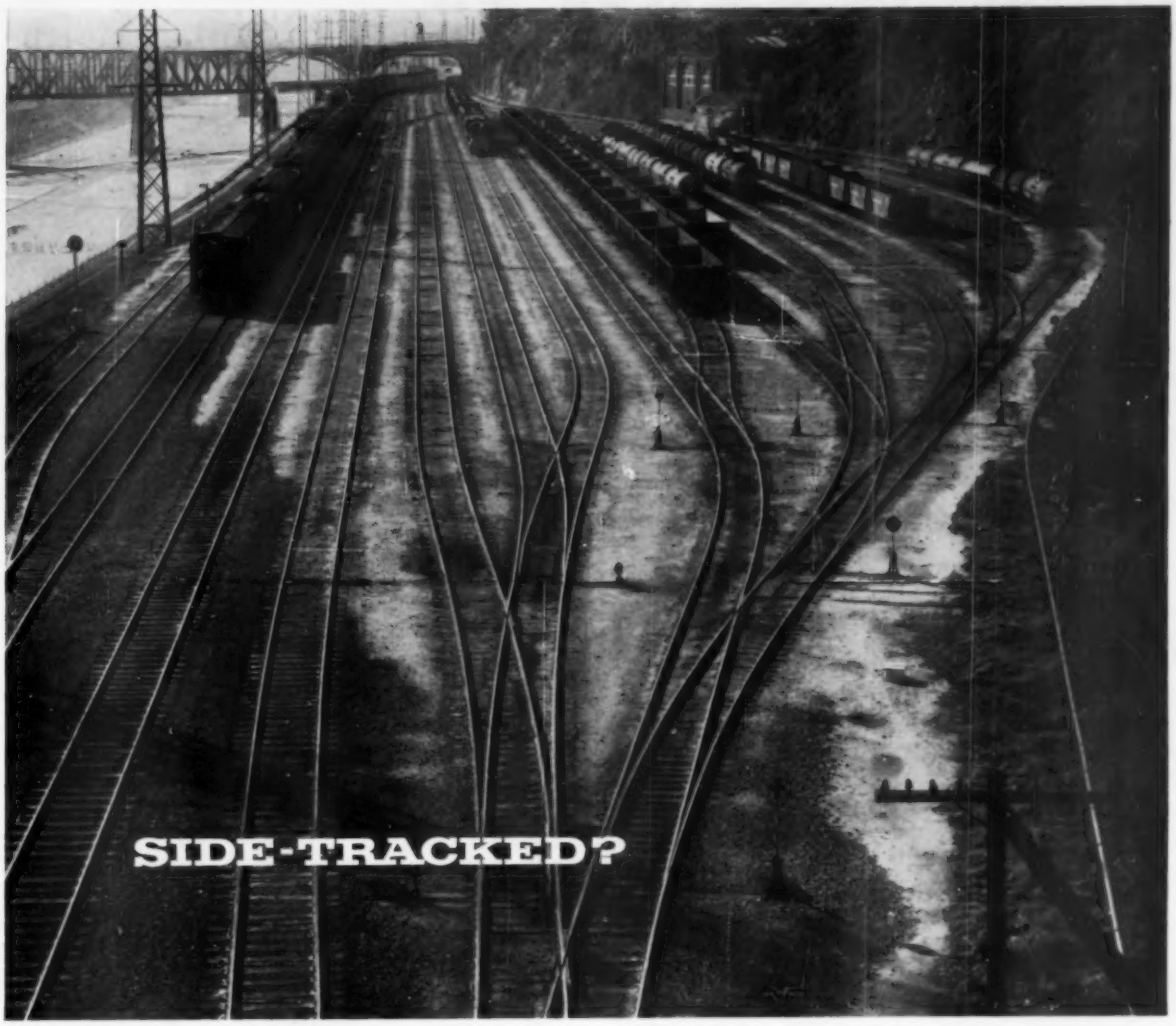

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Straight line planning and thinking are required to reach a destination or attain an objective. The increasing complexity of automation and/or computer control systems presents many devious byways. Some of these may prove to be just "spur tracks" that get nowhere—fast. Others may eventually connect with the main line, but with long delays and bad connections. Librascope's ability to combine techniques has cleared the tracks and brought many industrial and military projects through to very successful conclusions. Industrial control systems and computers involving mechanical, electrical, electronic, magnetic and optical techniques—military weapons systems and computers, controls and navigation devices—are particular fields in which LIBRASCOPE records outstanding accomplishment. Our experience and production facilities might aptly be applied to your particular problem. Write today for further details.

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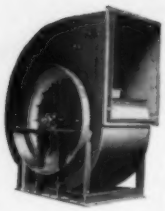

Many of the world's outstanding plants and public buildings use "Buffalo" Fans like this Type BL Limit-Load Ventilating fan. Bulletin F-102.

Precise, reliable control of temperature and humidity — plus air cleaning — yours with sturdy, quiet air conditioning units like this "Buffalo" PC Cabinet. Bulletin 3703A.

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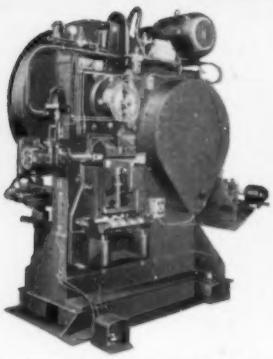

There's a "Buffalo" machine for every punching, cutting, shearing, blanking or bending job. Above, the "Buffalo" Billet Shear. Bulletin 3295C.

In addition to this famous "RPMster" with variable speed drive, "Buffalo" builds six lines of shop-proven drills to meet every requirement for low-cost drilling. Bulletin 3257B

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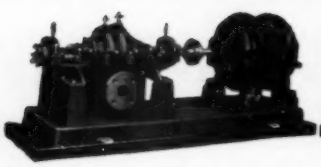
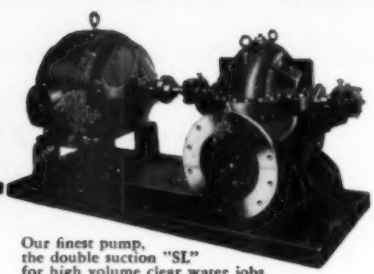


One of many types of "Buffalo" Centrifugal Pumps, the husky "RR" is widely used on high pressure jobs like boiler feed in power plants. Bulletin 980D.



Our finest pump, the double suction "SL" for high volume clear water jobs. Others include chemical, paper stock, close-coupled. Bulletin 955Q.

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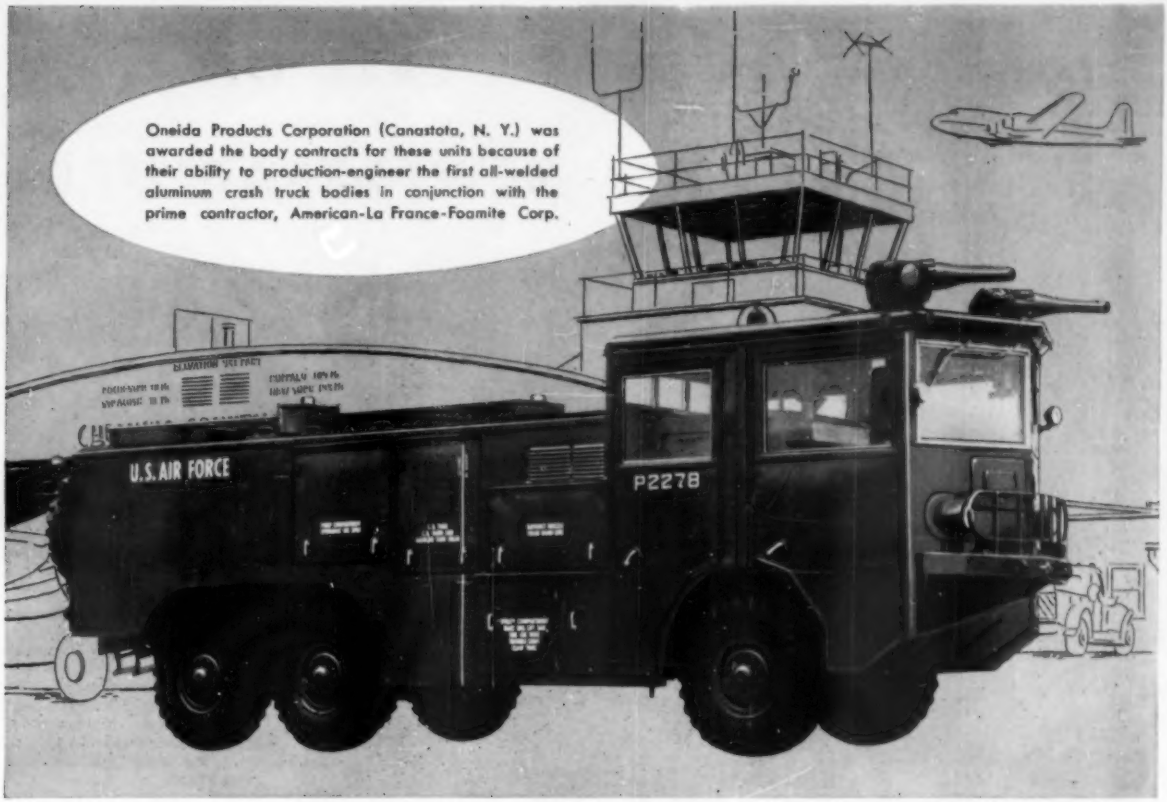
Oneida Products Corporation (Canastota, N. Y.) was awarded the body contracts for these units because of their ability to production-engineer the first all-welded aluminum crash truck bodies in conjunction with the prime contractor, American-La France-Foamite Corp.
U.S. AIR FORCE
P2278

When seconds count most—
ALUMINUM'S LIGHTNESS PAYS OFF!

Split-second timing is often the difference between life and death when an airplane is involved in an accident. Recognizing this, the Air Force has adopted the new Model 0-11A Crash Truck—constructed almost entirely of strong, lightweight Alcoa® Aluminum. From a dead stop, these bright red monsters leap to 50 miles per hour in just 45 seconds! In time trials, their crews have answered emergency calls and extinguished a fire in less than one minute!

To reach accidents in rugged terrain surrounding the airfield, crash trucks must negotiate rough, open country at high speeds without damage. And for rough service like this, the truck bodies must be strong and durable. Due to its high strength factor, an all-welded body was selected . . . and specifications call for Alcoa Aluminum.

In all, the 0-11A Crash Truck bodies contain 6,000 pounds of aluminum—with more than 24,000 inches of welding in each body. Completely assembled, these crash trucks offer further assurance that the Air Force—in the air or on the ground—looks after its own.

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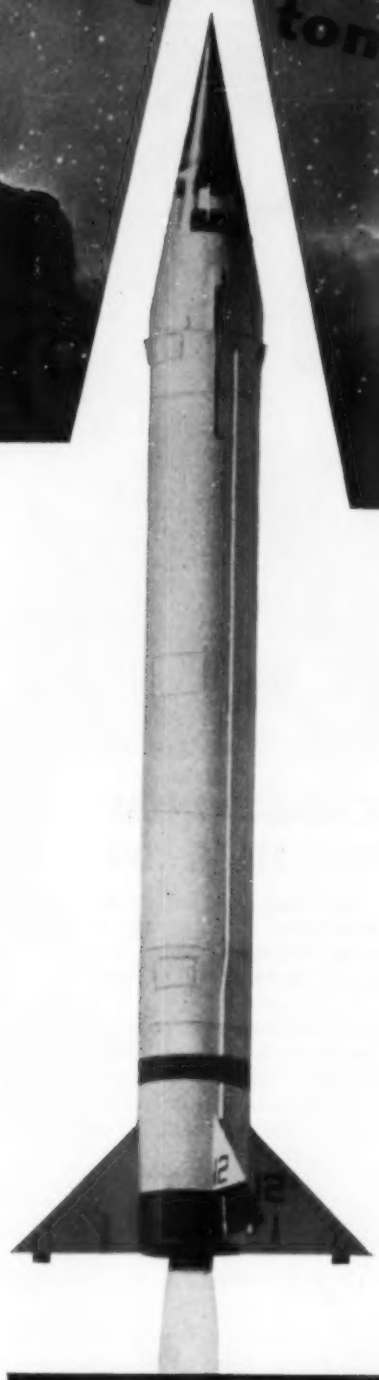

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toward tomorrow.

Conceived and developed
by a team of Martin people
who have been working with
Navy scientists since 1946,
Viking 12 is the latest of a series of
high-altitude research vehicles.

It was designed to explore the
problems of controlled flight
in the near-vacuum conditions
of the outer atmosphere and
at speeds in excess of 4,000 m.p.h.

In this long-range Viking program,
technical problems are
continuously being solved
which support advancements that
are now being made toward the next
frontier of flight—rockets having
intercontinental ranges.

And beyond that lies space itself!

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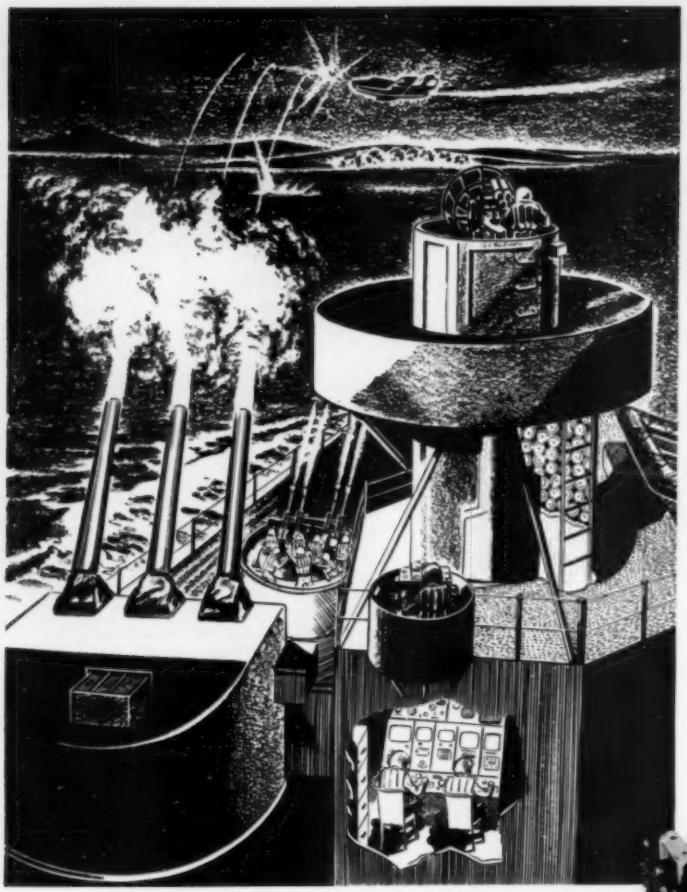
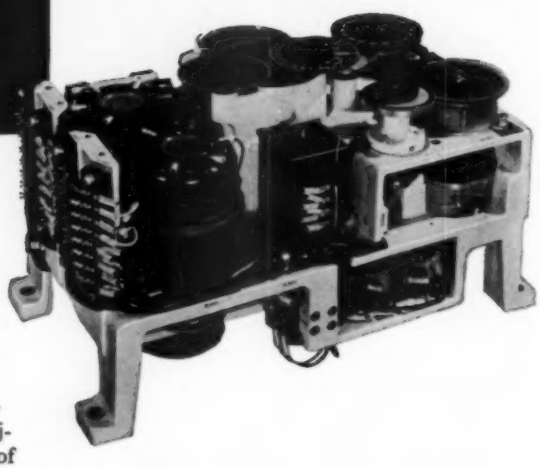


Atlas Built Parallax Correcter Helps Keep Guns

ON TARGET IN ANY SEA



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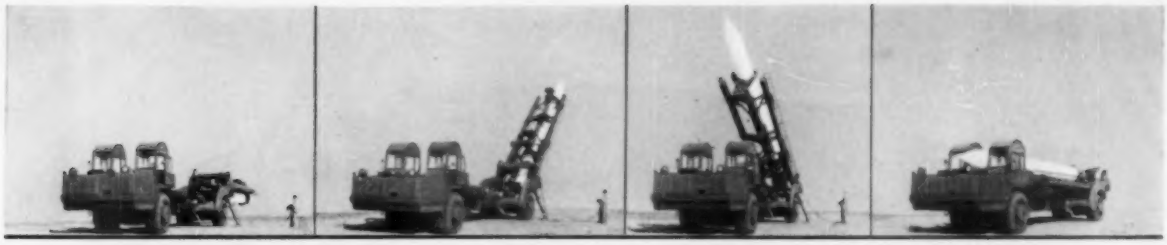

TODAY LeTourneau Builds the Corporal Loader

Another Machine for America's Defense Powered By LeTourneau Electric Wheels

Supersonic speed and terrific striking power are only two of the big advantages built into the Corporal Guided Missile Weapons System.

Key factor in making this sleek new missile a successful tactical support weapon is *ground mobility* – the prime function of the *LeTourneau Corporal Loader.*

This powerful vehicle picks up the missile in rear storage areas, carries it "piggy-back" over highway or battlefield terrain to any forward area launching site, and erects it on the missile launcher for firing.

All these functions are handled with the same positive system of electric driving power and electric control that is now being utilized on other LeTourneau machines for America's defense, as well as for exploration, logging, land clearing, and other heavy industries. Corporal Loaders are now being delivered to troops.

The engineering and manufacturing facilities of R. G. LeTourneau, Inc., are ready now to help solve *your* problem. The Corporal Loader is substantial evidence that it *CAN* be done . . . with LeTourneau.

These photos show how Corporal Loader handles missile for delivery to launching site. This machine was designed and built in conjunction with Firestone Tire & Rubber Company, producers of the Corporal Guided Missile.

G 101

LeTOURNEAU LET EQUIPMENT

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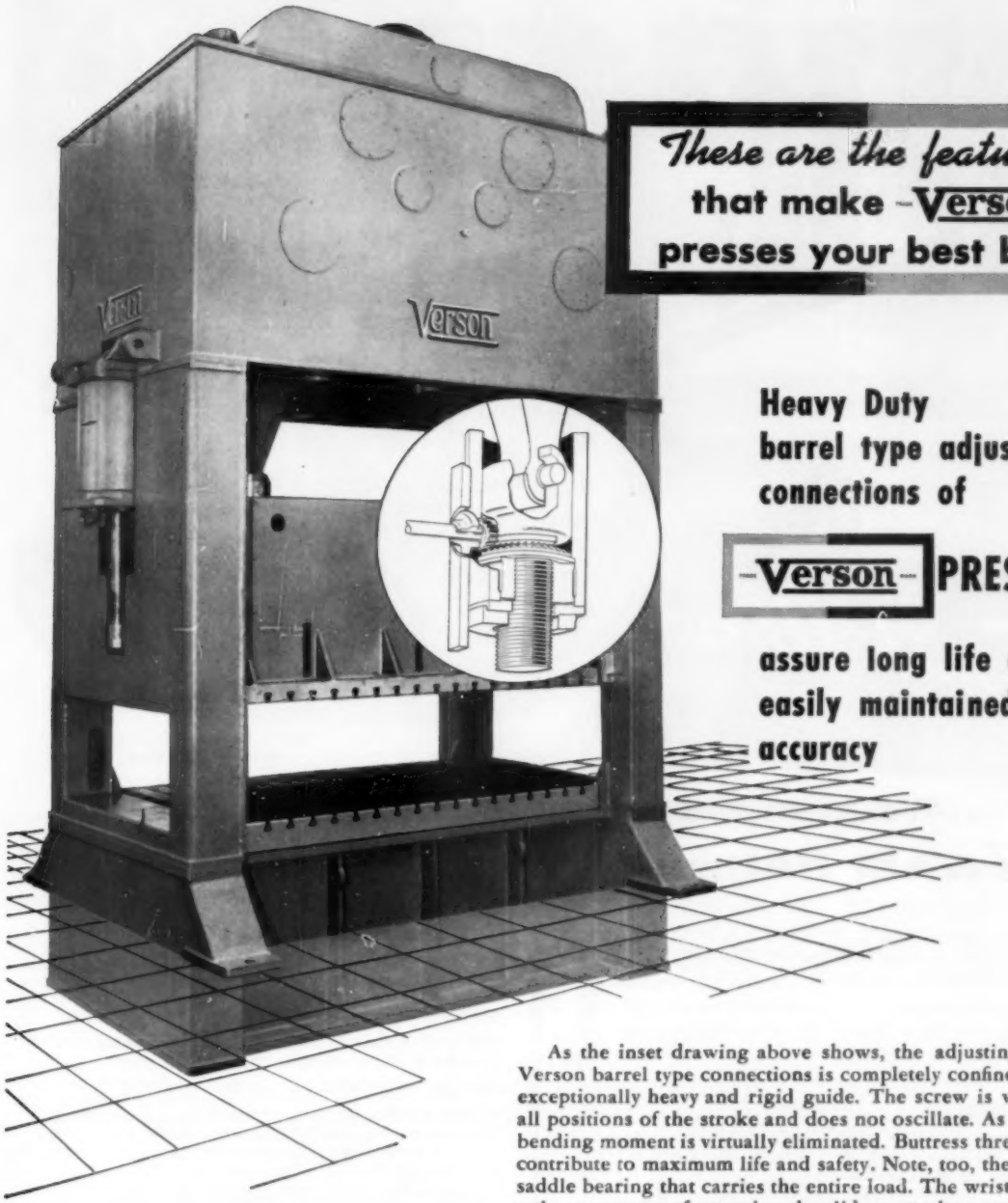

These are the features that make -Verson- presses your best buy

Heavy Duty barrel type adjustable connections of -Verson- PRESSES assure long life and easily maintained accuracy

As the inset drawing above shows, the adjusting screw of Verson barrel type connections is completely confined by an exceptionally heavy and rigid guide. The screw is vertical at all positions of the stroke and does not oscillate. As a result, bending moment is virtually eliminated. Buttress threads further contribute to maximum life and safety. Note, too, the heavy saddle bearing that carries the entire load. The wrist pin serves only as a means of returning the slide to stroke up position.

Adjustment can be manual or motorized. In either event, the extra long adjusting screw provides exceptionally liberal adjustment.

This is another example of the kind of engineering that has won for Verson presses their reputation for quality. For you, it all adds up to better stampings at lower cost. Whether you require a single press or an entire stamping plant complete with tooling, we'll be pleased to make recommendations.

Catalog G-53 presents basic data on the entire Verson line. Write for your copy, today. It may be the first step towards the more efficient production of stampings.

Verson Press for every job from 60 tons up.

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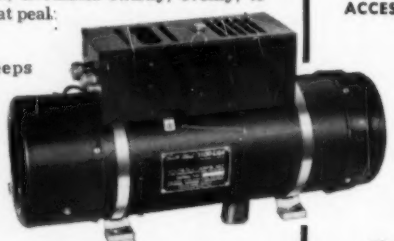
3. Windshield Defrosting. Keeps windshield reliably "frost-free." Assures clear vision, safer driving.

Two of these 30,000 BTU Heaters—Model 1030-D are standard on the Patton—



FACTS FOR THE ENGINEER WITH A HEATING PROBLEM

Data given are typical for the 30,000 BTU heater — data for other sizes provided upon request.

ENVELOPE—Can be fitted into a space 19" x 10" x 7".

FUEL—Will operate on automotive, aircraft, kerosene and jet fuels with fuel pressures of from 1 to 15 lbs.

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POWER REQUIRED—For 12 volt systems—approximately 245 watts starting and 110 watts running. For 24 volt systems—approximately 365 watts starting and 144 watts running.

INSTALLATION—Bracketry available for installation in most operating positions.

ACCESSORIES—Inlet and outlet adapters, fuel pump, power control, wiring harness, exhaust and vent ducts are engineered and provided to suit your particular application.

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WINDSHIELD DEFROSTING
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There's a South Wind Heater for every heating need

Do you have a heating problem? Write today for the experienced counsel of South Wind field engineers on any problem in internal or external pre-heating or space heating. The wide range of South Wind Heaters includes 20,000—30,000—50,000—100,000—200,000 and 600,000 BTU/hr. capacities. Write South Wind Division, Stewart-Warner Corporation, 1514 Drover Street, Indianapolis 7, Indiana.

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Modern design, air-cooled Kohler Engines in sizes from 2.5 to 26 H.P. offer a power range to fit all applications requiring a reliable and economical power source.

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When you have a transformer problem, call on

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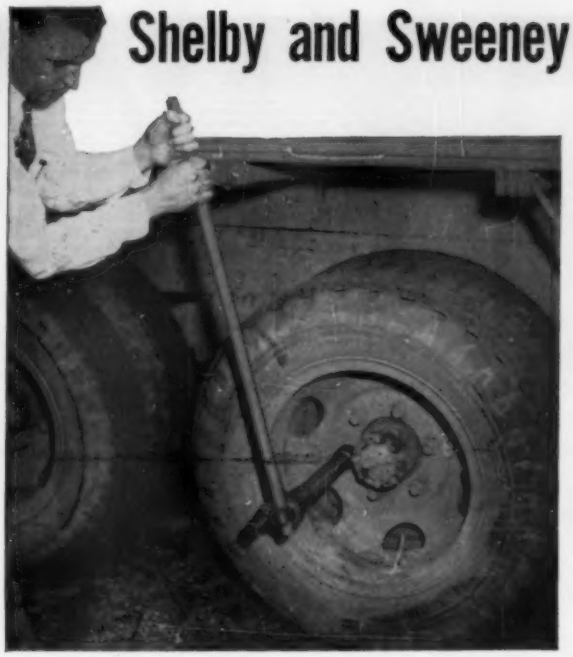
Shelby and Sweeney tame a tough nut



● The Sweeney POWERENCH is a rugged nut turning tool specially designed with geared action for tightening or loosening the nuts on dual wheels, aircraft propeller shafts, diesel engine cylinder heads, railroad locomotives, and for countless other heavy-duty applications.

Super tough equipment calls for super strong materials. That's why Shelby Seamless Mechanical Tubing—in sizes from 1⅛ in. O.D. to 5⅝ in. O.D.—is used in the manufacture of POWERENCH assemblies. The great strength, complete uniformity, and extreme dimensional accuracy of Shelby Seamless make it the ideal mechanical tubing for the fabrication of such heavy-duty materials. Moreover, it is safe and workable—possessing excellent machining and superior welding properties.

Produced to exacting standards by the world's largest manufacturer of tubular steel products, Shelby Seamless Mechanical Tubing is available in a wide range of diameters, wall thicknesses, various shapes and steel analyses. Call on our engineers for recommendations. They will be glad to make a study of your particular requirements and help you apply Shelby Seamless to your specifications.

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All Shelby Seamless Tubing is pierced from solid billets of uniform steel. This is the one manufacturing method that assures absolute uniform wall strength.

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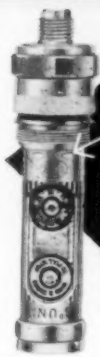
SHELBY SEAMLESS MECHANICAL TUBING

UNITED STATES STEEL



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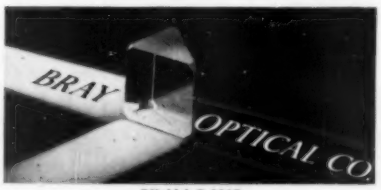

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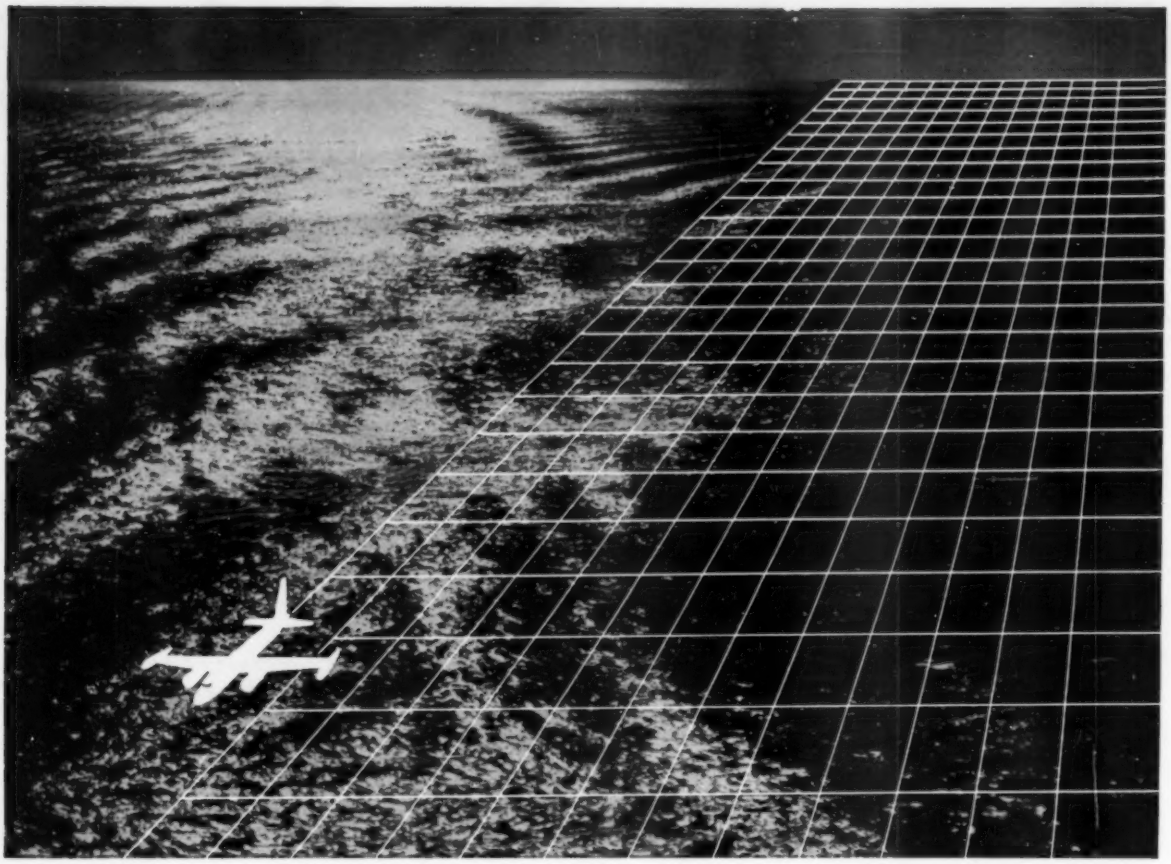

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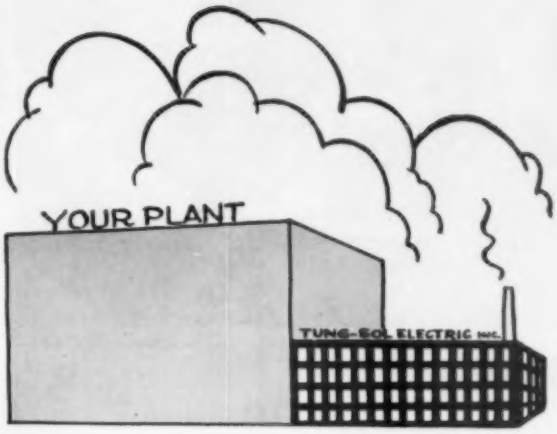

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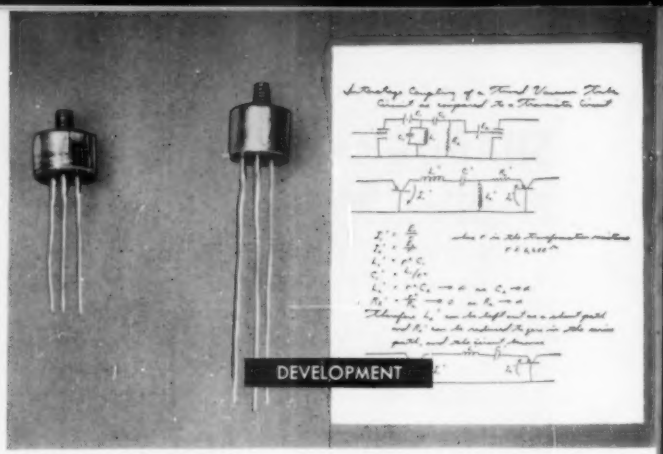

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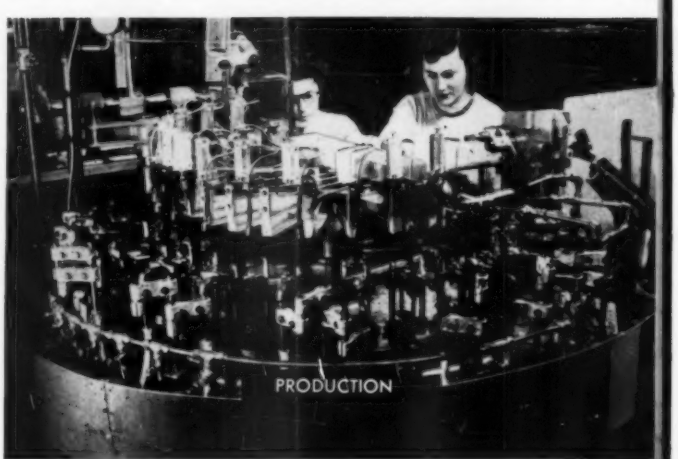

ARMAMENT TECHNOLOGY

This section of ORDNANCE contains articles of a detailed and technical nature on ordnance research, development, manufacture, field use, and related subjects.

Steel Shell Manufacture

A Consideration of the Pros and Cons of Hot-forging and Cold-forming

Dr. Arthur F. MacConochie

Head of the Department of Mechanical Engineering, University of Virginia, Charlottesville, Va.

IN this discussion we shall concern ourselves principally with the processes of making the type of shell which is, essentially, a tube having one end with the base closed and the other squeezed to an ogive and plugged with a fuze. Nothing but steel will serve for this severe duty. Isotropic materials, such as glass, although much stronger than steel and, of course, much more highly "notch sensitive," will not answer.

Even if capable of standing the severe punishment in the gun, they would not serve our purpose at all well on detonation of their high-explosive charge at the target. For a rather curious reason, unknown to many enterprising inventors who have proposed glass containers for hand grenades and the like, glass will not shatter into lethal fragments as steel will.

It is now known that the physical properties of steel under very high rates of loading, such as are encountered in the neighborhood of detonating explosives, differ markedly from those in evidence under static test. In particular, the elongation, as evidenced by spark photography of a bursting bomb, appears to be greatly increased.

Thus, during the extremely rapid expansion of the body of the shell during detonation, very high accelerations result in fragment velocities of several thousand feet a second. These flying fragments are the real casualty producers since the body of a man—or a goat—as Barlow found to his dismay, can take an extraordinary amount of punishment from an explosive wave.

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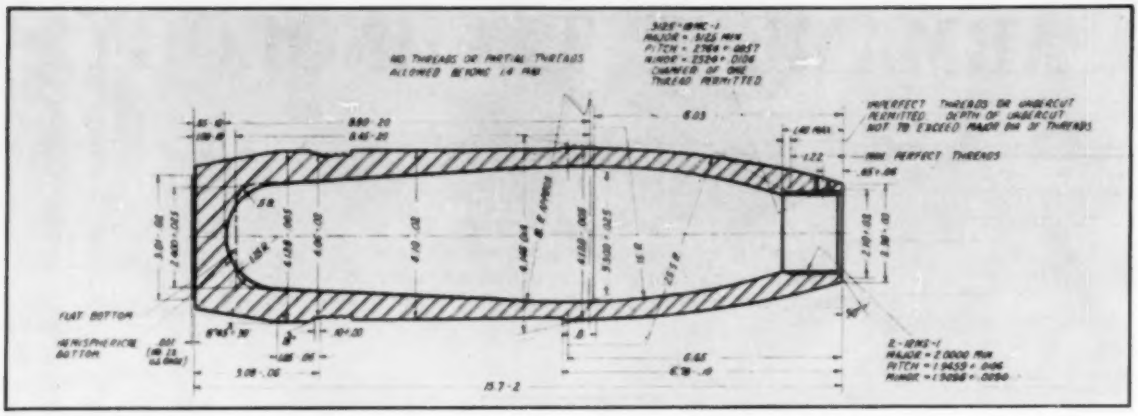
Applications are increasing

Glass, however, does not behave in this way. Lacking the crystalline characteristics which distinguish solids like steel from isotropic materials, it blows to a powder of relatively low particle velocity a short distance from the scene of action, instead of slipping along the cleavage planes, as steel does, prior to eventual rupture.

GRANTED, then, that for several reasons—including those outlined above, together with its ready availability at low cost—we must use steel, how can this very satisfactory material be compelled to assume the shape of a shell? We can, and do, machine missiles, such as 37-mm. armor-piercing shot, out of the solid bar. But for medium and large calibers this would be an indefensible waste of material and effort.

The writer explored the possibility of casting shell under high static or centrifugal heads rather thoroughly during the last war, and it may not be necessary to recapitulate here all the objections to the liquid shaping of shell.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Cutaway drawing showing specifications required in the manufacture of 105-mm. shells either hot- or cold-forged.

It is practicable, of course, if any advantage is to be gained (*e. g.*, relieving a bottleneck in the bar mills) to cast the billet from which the shell will subsequently be forged, and many shells have been made in the past in this way.

The familiar way to make a shell is to pierce a heated billet, set in the die or "pot" of a hydraulic press, and subsequently draw the cup through dies. The principal advance in this method was the "forge finish" of the cavity, as practiced during the Second World War.

FURTHER, instead of the round billet, characteristic of earlier practice, square billets with rounded corners were very largely employed during the last war on the theory that radial displacement of the metal during the pierce, in the process of filling the die, imposes less load on the punch than rearward extrusion.

In the larger calibers, one observes a tendency to retain rounds, either parted off from the bar or cast and separated by flame cutting. But in such cases the round slug often rests on the upper lip of the conical frustum in the base of the die designed to shape the boattail of the shell. Thus rearward extrusion is minimized in this case also.

Punches still run off center, however, particularly if the slug is unevenly heated or cooled before forging. As little as fifteen degrees Fahrenheit difference in temperature between one side of the billet and the other is sufficient to cause the punch to run to the hotter side. But cold steel, when cupped from a disk, can produce "thick and thin" so there are other causes of this phenomenon also.

Above all, the techniques of pierce and draw had been so improved by 1940 that the "forge finish" of the cavity of the shell became standard practice and machining entirely eliminated in favor of the shot blast which cleans up the scale and leaves a surface like frosted silver.

Although doubtless the most favored procedure, piercing the slug and subsequently drawing it through ring or roller dies is not the only way to forge a shell. It can be done on the upsetter by heating the end of a bar that is more than twice as long as is required to forge one shell. Using the cool end as a tong hold, a shell can be forged on the other in perhaps half a dozen successive operations in a multiple punch and die sequence.

For some sizes, at least, the upsetter is not at a disadvantage compared with pierce and draw. As a matter of fact, considering all the different ways of forging shell, during the last war the forged blanks all cost from 3.8 to 4.2 cents a pound.

THEN, too, we had an adaptation of the seamless tube mill, making cups from round stock. A principal hope in this case, was the improvement in concentricity of the cup, as compared with pierce and draw. The matter of concentricity, of course, is of the greatest importance since sufficient material must be left on all shell forgings to keep the percentage of "wasters" that do not clean up on machining within bounds.

This, by the way, is the principal objection urged by the proponents of cold-forming against hot-forging; namely the thirty-five to fifty per cent of the original billet which does not appear in the finished shell as a result of trimming and other machining operations.

It is contended, in defense of hot-forging, that the steel removed from the blank in the machine shop is not "lost," and that only the shell itself is expendable. Physically speaking, this is substantially true. What *is* lost, of course, is the effort, in terms of man-hours and overhead on steel mill equipment, transportation, and the like, that was put into the original bar-stock equivalent of the scrap and chips to make a serviceable product.

MUCH of this effort has to be put forth over and over again, as the circling river of scrap flows through the mills on its journey to the shell forges and machine shops and thence back again to the open hearth. If one is so minded, there are other, and more cogent arguments in favor of retaining the old, reliable pierce and draw, at least for many applications, until such time as more mature experience and the steady advance of shell manufacturing technology dictates a major shift in policy.

But even in the present state of the art of cold-forming shell, with its lowered demands on alloys (notably manganese), shortages might force our hand, just as a lack of sufficient copper compelled the use of steel for cartridge cases during the last war.

The counselors of caution toward an overly enthusiastic acceptance of cold-

forming, as opposed to hot-forging and machining as a means of making shell, reasonably enough point to some other considerations of which we must take account. Steel at forging heat is in the austenitic condition, austenite being a solid solution of carbon in gamma iron and possessing characteristics similar to, but not identical with cool steel.

At room temperature, steel is ferritic and, to a slight extent in the case of the dead mild steels familiarly used in cold-forming, pearlitic. At forging heat, the face-centered austenitic lattices readily accommodate themselves to the torturing thrusts and squeezes of the hydraulic press or the hammer. They flow and regroup in finer grain size, the heavier the punishment.

THERE is a "healing" tendency in steel at forging heat which manifests itself in a large capacity to "bury" imperfections arising from the open-hearth and ingot-making stages of steel manufacture and in the virtual absence of that notch-sensitivity especially characteristic of cold-worked or, indeed, of any hard steel.

For this reason there appears to be little doubt but that steel which serves the shell forge well and rarely opens up under the press might on occasion give trouble in cold-forming.

The simple truth is that for cold-forming operations the cleaner the steel, the lower the contents of phosphorus and sulphur, and the smaller the percentages of such residuals as chromium, copper, and molybdenum, the better. In fact, if the sulphur exceeds about 0.03 per cent, the steel cannot be cold-extruded successfully. The percentage of residuals should not be greater than 0.20 per cent for trouble-free operation.

Thus a single, or indeed several, suppliers might not be able to furnish all the steel necessary, even for a particular item. And if the manufacturer procured his steel from more than one source, his operations might have to be adjusted accordingly.

Certain steels, for example, harden more under cold work than others, necessitating additional annealing operations which might not help because of the risk of grain growth and consequent increased possibility of cracking in the draws.

This excessive tendency to work-harden could arise from the presence of silicon in excess of the tolerable 0.10 per cent recommended by one facility. This producer uses steel which is fully killed and hot-topped, thus ensuring finer grain and less risk of the stringer type of inclusions ordinarily found in silicon-killed steels.

THIS might well bring us to the point of inquiring whether any sort of compromise is practicable between hot-forging and cold-forming—a sort of middle course in which scaling would be largely or wholly avoided by rapid heating of the slug, by induction or by gas, to somewhat lower temperatures than are now customary in forging. A neutral atmosphere, rich in carbon monoxide or lithium, might also be employed. These hot operations would be confined to the earlier stages of the entire process in which a cup is formed.

But greater care in the heating and the partial cooling of the slug prior to forging would have to be taken lest we be plagued, as in the past, with eccentricity of the cup. After hot-forging of the cup, cold-forming would be re-

Technician checks the outside measurements of a 105-mm. high-explosive shell manufactured by the Mullins Koldflo process.

tained for the later operations of forward extrusion to length, expansion of the bourrelet, and nosing, in order to bring up the physicals and preserve the other desirable characteristics of the cold-formed blank.

In this way we might not only render a wider range of steels acceptable but reduce the demand for presses of large capacity.

By way of specific illustration of the present status of the manufacture of cold-formed shell, the 105-mm. starts with a slug sawed from a 5-inch round. This is chamfered and buffed, pickled to remove any mill scale, then given a phosphate coat, followed by a soap coat for lubrication in the die.

THE phosphate coat acts as host to the lubricant in the first squeeze, called a sizing operation, in which the slug begins its progress through a series of heavy squeezes, in various punch and die combinations aimed at producing an elongated, boattailed cylinder with tapering walls and a closed base.

If this process is considered, it will be apparent that any attempt to change the shape of the cylindrical slug to a long boattailed cylinder in one operation would be doomed to failure, not only on account of tooling problems but also because of the increase in resistance and the mounting risk of cracking as manipulation work-hardened the steel. The process is, therefore, subdivided.

Thus, in the earlier stages, the sized slug, with its centering depression in the upper end, is subjected to "backward extrusion" of the walls to form a cup. Thereafter this thick-walled cup is "extruded forward" by a punch and die combination in which the body of the punch fits the upper portion of the die like a piston and, by the exercise of considerable pressure, causes plastic flow of the steel through the annular opening between the extended nose of the punch and the die. In this manner the body of the shell is lengthened as the steel runs ahead of the punch.

The reader who is familiar with the operation sequence in manufacturing shell from forgings would be at no great loss if he attempted to visualize the remainder of the process by which the cold-formed body becomes a finished shell. He would have to remember that we try to avoid breaking the smooth, satinlike skin with tools except where, at present, we must; namely, the groove for the driving band. Thus, the protuberances of the bourrelet are squeezed out instead of being machined out of the body and, later, ground.

In this same operation, the flared lip left around the mouth in the forward extrusion process is ironed out in preparation for nosing. As in the case of the forged shell which has arrived at this point after a series of machining operations, there remain nosing and tapping, operations pertaining to cutting the band groove and seating and machining the driving band.

As in the base of hot-forged shell, a base plate is now welded on, lest basal porosity permit the entry of propellent gases during the flight through the barrel of the gun.

The operation sequence in cold-forming might be summarized and identified for comparison with the operation sequence of the hot-forged and machined shell as shown in the table below.

Comparison of operation sequence in cold-forming and hot-forging shell.

COLD-FORMING	*FORGING AND MACHINING*
1. Sawing the slug	1. Billet separation
2. Deburring and buffing the slug	2. Heating for forging
3. Pickle, bonderize, and lubricate	3. Descaling
4. First squeeze to cabbage	4. Pierce
5. Same as 3	5. Clean cavity
6. First cupping (rearward extrusion)	6. Draw through dies
7. Grind out any seams	7. Cooling after forging
8. Full anneal	8. Cavity shot blast
9. Same as 3	9. Cutting blank to length
10. Second cup (rearward extrusion)	10. Centering the base
11. Same as 3	11. Rough turn
12. Third cup (rearward extrusion)	12. Heating for nosing
13. Same as 3	13. Nosing
14. Extend by forward extrusion	14. Heat treatment
15. Same as 3	15. Testing for hardness
16. Expanding bourrelet	16. Second shot blast
17. Nosing	17. Bore nose and chamfer
18. Stress relief	18. Finish turn the body
19. Same as 3	19. Finish base
20. Bore nose and chamfer	20. Machine band seat
21. Machine band seat	21. Thread nose for fuze
22. Grind the bourrelet	22. Grind the bourrelet
23. Thread nose for fuze	23. Squeeze on band and machine
24. Squeeze on band and machine	24. Weld on base plate
25. Weld on base plate	25. Paint
26. Paint	

ON paper, at least, it does not appear as though there was much to choose between cold-forming and hot-forging, including machining, as far as the number of separate and separable operations is concerned. If presses are heavier and tooling more of a problem in cold-forming, tools last longer as a result of operating on a cool blank. For example, piercing punches in hot-forging last only some three to six hundred shells before requiring redressing and may have a total life of about two thousand shells.

By comparison, George E. Whitlock reports in ORDNANCE that "good punch life varies between 50,000 and 200,000 pieces before redressing, depending upon the size of the (cold-formed) shell. By using carbide, the piece rate can be greatly increased."

If superior steel must be used, less of it is required per shell and more than proportionately less manganese. For instance, since the finished weight of a 105-mm. shell is around 25½ pounds, hot-forging will call for a billet weighing about 42 pounds—entailing a scale and chip loss of 17 pounds.

Cold-forming necessitates no more than a few extra ounces on the original slug and a total scrap loss from all causes of about five or six pounds per shell from all causes.

Ceramics for Rockets

Lining the motors of jet-propulsion power plants with ceramics can solve the troublesome problems of heat transfer and the erosion of the nozzle throat due to chemical or mechanical causes

W. H. Duckworth and J. J. Krochmal

OUTSTANDING progress has been made during the past few years in developing ceramic-lined rocket motors. For example, in 1946, the firing time of a particular uncooled motor was limited by nozzle erosion to something like twenty seconds, even when an inefficient propellent-mixture ratio was used to keep conditions mild.

Today, using a propellent-mixture ratio that gives close to optimum performance, ceramic-lined versions of this motor are practically indestructible. Continuous firings of over five minutes' duration and numerous repeat firings do no damage to them.

This example is given to indicate progress, not to imply that a clear-cut solution exists to obtaining a satisfactory service life from all rocket motors. There are a variety of motors, and each presents an individual problem requiring experimentation to arrive at a ceramic lining that will yield satisfactory service. However, considerable background in materials and designs has been developed to guide such experimental work.

A ROCKET motor is a jet-propulsion power plant that does not use atmospheric oxygen for combustion. For practical purposes, the forward momentum, or thrust, it produces is the reaction of a jet of hot gases ejected rearward. The action producing this reaction is the product of the mass and velocity of the gases upon exit. In the interests of a high gas velocity, hence a high thrust, it can be shown that the gases should be as hot as possible.

Figure 1 is a schematic drawing of a rocket motor. To produce a supply of high-temperature gas in the chamber, chemical reactions are utilized. Although the reaction of a solid charge placed in the chamber can be used, this discussion is confined to the reaction produced by feeding liquid chemicals, or propellants, continuously into the chamber.

UNCOOLED, liquid-propellant rocket motors, to be useful, impose unprecedented temperature demands on the materials of construction. Temperatures of the order of 4,000 to 7,000 degrees Fahrenheit and pressures of 300 to 1,000 pounds per square inch in the combustion chamber must be considered.

Operation may be anywhere from five seconds to, perhaps, thirty minutes. The exit gases reach sonic velocity at the throat of the nozzle and supersonic velocities downstream from this point.

In the case of ceramic-lined rocket motors, the ceramic material has two functions: to maintain the inner contour of the chamber and nozzle and to prevent a metal stress-bearing housing from becoming overheated. Heat-transfer rates are greatest at the nozzle section, and motor performance is affected more by changes in area at the throat than at any other section. It follows that the nozzle section presents the most difficult lining-material problem.

The major advantage in utilizing ceramic-lined rocket motors at the present is simplicity of design which in turn leads to low-cost mass-production techniques. Another saving is that of critical materials and even steel itself, which, in time of war, is also a vitally important resource.

THE question of performance of regeneratively cooled versus ceramic-lined uncooled units is one yet to be answered. In cooled units, the coolant propellant absorbs heat which is again made available for combustion when the coolant eventually reaches the combustion chamber. In uncooled units, some heat energy is lost through the walls to the atmosphere.

These losses are minute when compared with the over-all combustion process and may never be missed since the hot inner wall of the uncooled unit tends to improve the quality and char-

Mr. Duckworth is chief of the Ceramic Division, Battelle Memorial Institute, Cleveland, Ohio. Mr. Krochmal is project engineer, Power Plant Laboratory, Wright Air Development Center, Dayton, Ohio.

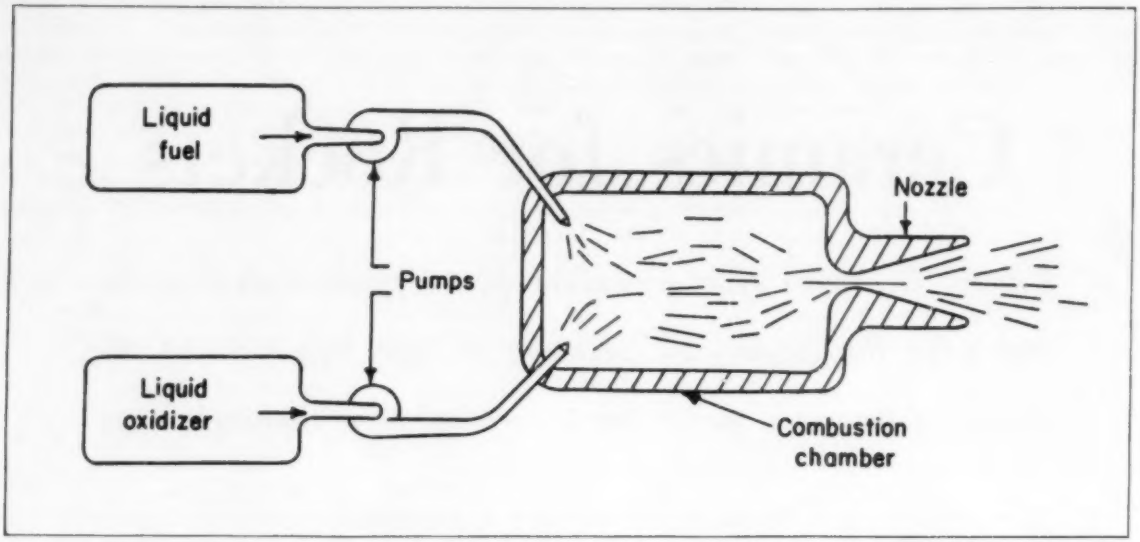

Fig. 1. Schematic drawing of an elementary rocket motor showing fuel containers, feed lines, and combustion chamber.

acter of combustion. It is conceivable that severe requirements of future motors might require the use of both ceramic linings and regenerative cooling.

Weight is an important factor in rocket motors. No blanket statement can be made as to the superiority of either uncooled or regeneratively cooled designs in this area of consideration. It must be stressed that each application should be considered individually with the two design techniques.

If a weight advantage exists in the uncooled unit, no question exists as to the final choice. If no weight advantage or disadvantage is apparent, simplicity and cost then become the deciding factors, and again the choice will favor ceramic-lined uncooled units.

A SPECIFIC ceramic material may be satisfactory for the nozzle of one motor and not for another. Among the materials that have performed successfully, but not universally so, are the refractory oxides, zirconia and beryllia, various special silicon carbide bodies, graphite, and zirconium boride.

As evidence of the variability of conditions for different rocket motors, let us consider the properties of these materials in a general way. All of them have high melting points, above 3,600 Fahrenheit, but the temperature at which they exhibit plastic deformation varies considerably. Their hardnesses and thermal conductivities cover an extremely wide range. The refractory oxides are, of course, oxidation resistant, while bare graphite is readily oxidized.

Although, as indicated, extremely wide ranges of most properties are covered by the field of refractory ceramics, all of them are brittle. They can deform very little without fracturing. For this reason it is necessary that ceramic linings be supported intimately and uniformly in the metal housing. Otherwise, in transmitting the sudden pressure loads to the housing, stress concentrations will cause cracking and spalling. Real progress in developing ceramic-lined motors began when this fact was realized and accounted for in designs.

In the usual design of ceramic-lined rocket motors, a cast or rammed ceramic backing material is used in the annulus between the preformed ceramic lining and the metal housing. Castable ceramics have been developed specially to provide certain properties. In particular, they must not shrink upon setting and curing, or they will not provide the required uniform and intimate support.

THE type of backing materials developed at Battelle Memorial Institute are lightweight refractory concretes or plaster mixes. Figure 2 shows the general design of a ceramic-lined motor employing a backing material.

Other advantages are gained through the use of this design. Some of the better ceramics for linings, such as silicon carbide or graphite, have relatively high thermal conductivities. Added insulation provided by the backing material can alleviate problems caused by overheating of the metal housing.

The use of the backing material also eliminates the need for close tolerances on the outside diameter of the ceramic lining, thus reducing fabrication costs. Lastly, motors of this design are rather easily and cheaply assembled.

Schemes that do not involve backing materials have also proved successful. In these cases, uniform support of the ceramic is provided by direct contact with the housing, making their use unattractive for linings of high-conductivity ceramics.

SMALL tilelike segments of ceramic have been used to build up the lining. As can be seen, this particular design introduces complications in fabrication and assembly not encountered with sleeve-type linings.

In another case, intimate metal shells have been applied to the outside of the ceramic liners by flame spraying or electroplating. These were then machined and shrunk into a steel sleeve.

The problem of lining the chamber section seems to be pretty well in hand. Many uses for rockets require only one shot, allowing the use of common refractories in the chamber section. In fact, the use of a preformed chamber

liner often appears unnecessary; rather long duration firings have been made with the cast backing material exposed in the chamber section.

As mentioned earlier, the severest conditions in a rocket exist at the throat section. Sometimes relatively expensive materials or materials which are difficult to fabricate into large or complex shapes are necessary to withstand these conditions. In such cases, designs have been used successfully where throat inserts of the special material are placed in nozzles of other ceramic materials.

FOR example, a simple ring of a very hard, dense refractory might be used for the throat in a relatively soft, easily machinable graphite nozzle.

One can list several variables that affect the performance of ceramic linings, including: (1) Mechanical, chemical, and thermal properties of the lining material; (2) the type of design, including the properties of backing material and the amount of precompression in shrink fit, if used; (3) thickness of ceramic lining and of backing material; (4) injector design, or homogeneity of gases across various sections; (5) type of propellants; (6) ratio of components in propellant mixture; (7) size of motor; (8) chamber pressure; (9) firing duration.

From this list it can be seen that there are many factors that can be adjusted to achieve best performance from ceramic linings in a given motor. Unfortunately, these adjustments can hardly be guided by theoretical treatment, and the properties required for the ceramic components can be specified only in general terms. Service tests of the specific motor and keen analysis of the results, therefore, become the only tools for arriving at the best ceramic lining.

The causes of possible failure of the throat might be chemical attack, mechanical erosion, melting, or thermal stresses.

In the case of chemical attack, adjustments in the propellent-mixture ratio offer one means for correction. As another, the chamber might be lengthened so that gases are less corrosive at the throat. The material might be changed, either toward one less easily oxidized or reduced, whichever is indicated. If graphite is oxidized or mechanically eroded, hard protective coatings can be applied to it as a corrective measure.

Erosion of the throat often is localized at one or more points on the circumference. Refinements in the injector design to give a more uniform gas flow across the throat section have been used to eliminate this trouble.

Thermal-stress failures can be corrected in several ways. The heat-transfer conditions can be adjusted by changes in liner or backing-material thickness to reduce temperature differences, hence thermal stresses.

Precompression of the liner, through the use of a shrink fit or an expanding backing material, offers opposition to the critical thermal stresses. The porosity of the material can be increased to a point where thermal-stress cracks will not propagate in it and, by this means, the material made to resist failure.

HOWEVER, increases in porosity make the material weaker and more prone to failure by mechanical erosion. The use of the segmented-liner design reduces the size of the ceramic parts, and lower thermal stresses result.

Summarizing these remarks, ceramics for lining rocket motors are technically feasible and useful. Such assemblies are amenable to theoretical treatment to a degree, but the limitations and performance of each motor remain to be established by keen observations in service tests.

The limitations are imposed by design factors as well as material properties, but sound engineering practices are available both to the design and the ceramic engineer to reduce each conceivable limitation.

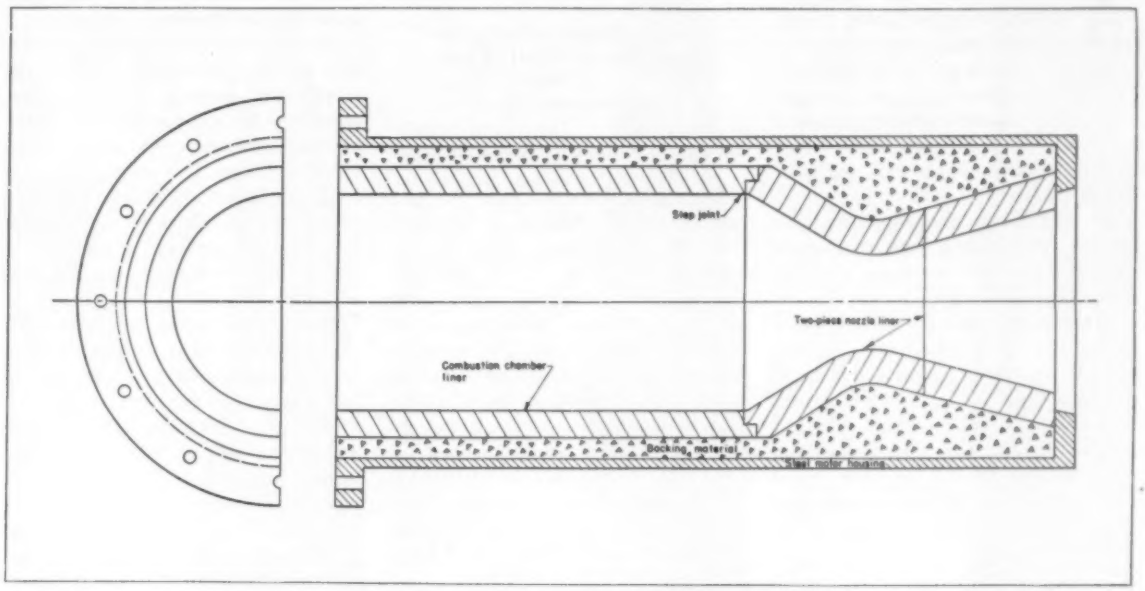

Fig. 2. Diagram of uncooled rocket-motor assembly shown in horizontal view at right; vertical cross-section at left.

New Rifles for Old

A discussion of the characteristics of the lightweight weapons now being tested by the Army and the Marines for possible acceptance as the standard small-arms to be used by United States combat forces

Capt. Charles B. Haslam

ARE lightweight rifles being considered to replace some of our standard small-arms weapons of today? Yes. For a number of years the Army and Marine Corps have been giving serious consideration to adopting a new rifle. The question immediately arises, "What is wrong with our present-day rifles?"

To answer that question it might be well to look back a number of years and ascertain why the Army and Marine Corps are seeking a new rifle.

Immediately after the conclusion of World War II, Ordnance personnel in this country agreed that a requirement existed for a new cartridge that could be fired from both rifles and machine guns. The objective was to develop the smallest possible round and yet retain the performance and stopping characteristics of the caliber .30 M2 cartridge.

IN 1947 a conference was held among the United States, Canada, and Great Britain to discuss a common round to be used by those three nations, but differences in military characteristics of the ammunition to be adopted precluded reaching an agreement.

The United States was committed to an all-purpose round to be fired from rifles and machine guns, whereas the United Kingdom was committed to a short, low-powered cartridge based on the premise that the round would be fired from rifles only.

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During the years that followed, various tests were conducted at the Aberdeen Proving Ground, Md., on the United States caliber .30, T65, ammunition and the United Kingdom's .280 or 7-mm. cartridge. These tests proved that the United States T65 ammunition was superior to the .280 cartridge in respect to penetration characteristics.

Adoption of a common round for use by the three aforementioned nations was so important that the subject was discussed at a conference of Defense Ministers of the United States, Canada, France, and the United Kingdom.

The two contending rounds were again the caliber .30, T65, ammunition of the United States, and the .280 cartridge of the United Kingdom. Once again the differences in military characteristics of both nations precluded an agreement being reached.

At this point, the three powers turned the entire matter over to the North Atlantic Military Committee of NATO and a working party was selected to conduct tests at the Aberdeen Proving Ground to determine the best cartridge. An agreement was not reached at this time, but certain recommendations were made by the interested powers.

The importance of adopting a suitable round was amplified when the subject was discussed by Prime Minister Churchill and the President of the United States during the former's visit to this country. At a military meeting held incident to the Prime Minister's conference, the Chief of the Imperial General Staff proffered a compromise round—the .280 bullet in the T65 case.

THE answer given by the United States was that if the United Kingdom were agreeable to an increase in cartridge power there would be little difference between the .280 cartridge and the caliber .30, T65, ammunition at the power level. Once again, an agreement was not reached.

Subsequent to the above conferences a committee known as the BBC was set up. This committee was composed of representatives of Britain, Belgium, and Canada. Its mission was to develop the best 7-mm. cartridge to compete in technical tests against the United States caliber .30, T65, ammunition.

Tests were conducted, and, as a result of these tests, the various nations interested in a common round for NATO recommended that the T65 ammunition be adopted. This recommendation was approved.

What is this T65 ammunition? This new ammunition is a caliber .30

(7.62-mm.) cartridge measuring only 2.8 inches in length. The bullet weighs 147 grains, and it is propelled to its target by the new ball-type powder which is designated M19 propellant.

Twenty rounds of the new ammunition weigh 1.04 pounds compared with 1.18 pounds for twenty rounds of the M2 cartridge. Strange as it may seem, the new ammunition is as accurate as the standard M2 round, and its exterior ballistics are on par with the M2 round.

THE NATO powers found themselves in a very unique position, since they now possessed a standard round and had no standard weapon to fire it. The United States and other NATO powers are now engrossed in a series of tests to come up with suitable lightweight rifles to fire the T65 or, as it is now called, "cartridge, NATO, caliber 7.62-mm. ammunition."

The U. S. Army has been testing lightweight rifles since 1950. The Marine Corps is in the process of conducting tests of lightweight rifles at the Marine Corps Equipment Board, Quantico, Va. The results of the Army's tests and the scope of the Marine Corps tests are classified and will not be discussed here. However, it may be said that at the present time the field has been narrowed down to two rifles. These are the Belgian Fabrique Nationale rifles and the American T44 rifles (see pictures).

The Fabrique Nationale rifles are manufactured by the Fabrique Nationale d'Armes de Guerre, s. a., Herstal, Belgium. The T44 rifles are test weapons developed by the Ordnance Department of the United States Army and are not being manufactured at present.

The Fabrique Nationale rifle falls into two categories: a light-barrel version and a heavy-barrel version. With a few exceptions to be described later, the rifles are identical.

The Fabrique Nationale rifle, hereafter to be abbreviated FN, was designed by D. D. Saive of the weapons design and development department of the Fabrique Nationale Company. In 1949 or 1950 it was chambered to receive the British .280 cartridge and later, at the request of the United States, was chambered to receive the new 7.62-mm. NATO cartridge.

The light-barrel version of the FN rifle measures approximately 41.5 inches in over-all length, exclusive of the new U. S. prong-type flash suppressor. With flash suppressor, the rifle measures about 44.5 inches over all. The rifle weighs approximately 8 pounds, 9½ ounces.

The weapon is gas-operated, fed from the bottom by means of a 20-round magazine, and contains a change lever located on the left side of the trigger group, permitting either semiautomatic or automatic fire at a rate of from 650 to 700 rounds a minute.

The weapon has a maximum range of 3,500 yards and a maximum effective range of 600 yards. The muzzle velocity is approximately 2,805 feet a second.

It appears that every effort has been made to get the center of gravity of the weapon in line with the axis of the barrel. This, coupled with the location of the gas cylinder on top of the barrel, tends to overcome the climbing of the weapon during automatic fire.

The rifle has a gas regulator which permits regulation of gases to the recoiling parts. The expended gases are dissipated by means of two small holes drilled in the top of the gas cylinder, approximately two inches from the face of the piston.

The rifle is designed so that a grenade launcher may be affixed over the flash suppressor. By rotating the gas cylinder plug 180 degrees, the gas port is shut off, and all the gases are then utilized to project the rifle grenade to its target. Rotation of the gas cylinder plug 90 degrees permits removal of the plug, piston, and spring.

The rifle is very simple to field strip. By cocking the hammer and pressing down on the locking lever the weapon can be broken similar to a shotgun (see illustration on page 1005).

The bolt and bolt carrier are then withdrawn through the rear of the cover. The bolt may then be easily removed from the bolt carrier, and, if so desired, the firing-pin retaining pin, firing pin, firing-pin spring, extractor, and the extractor spring may be removed.

The weapon

.280 British

T65 NATO

M2 U. S.

The T44 rifle disassembled. This light-barrel version resembles the standard U. S. rifle, caliber .30, M1.

employs a rocking-type bolt. When the change lever is set for semiautomatic operation, and assuming that a cartridge has been fired, the following action takes place:

As the bullet passes the gas port, which is located at the top of the barrel, a certain quantity of gas, depending on the setting of the gas regulator, passes through the gas port and impinges upon the face of the piston. The piston is driven to the rear, compressing its spring, and strikes the bolt carrier.

THE bolt carrier is then driven to the rear independently for a distance of about half an inch. After this independent travel, the ramps of the bolt carrier engage the cam of the bolt and the bolt is then lifted out of engagement with the locking shoulders. The action is thus unlocked, and the bolt and bolt carrier travel to the rear together, cocking the hammer.

During this rearward movement the bolt carries with it the spent cartridge case from the chamber and ejects it. The spent cartridge case, upon ejection from the weapon, strikes the right side of the cover, and lands to the right front of the shooter.

By this time the work of the piston has been accomplished and the piston returned to its forward position by means of the compressed piston spring. The bolt and bolt carrier are now brought to rest by the driving spring which has been compressed in the butt stock of the rifle.

The compressed driving spring now drives the bolt carrier forward. The bolt, carried by the bolt carrier, strips a cartridge from the top of the magazine and seats it in the chamber.

When the forward portion of the bolt reaches the face of the barrel the bolt carrier rides up and over the bolt, forcing the bolt down. This action engages the bolt in the locking shoulders.

At this point the extractor engages the rim of the cartridge. The bolt carrier, having completed its work, is held in its extreme forward position by the driving spring, and the weapon is ready to fire.

The above description covers semiautomatic firing. For automatic firing the procedure is the same except that, by means of the change lever, the weapon is allowed to fire automatically as long as the trigger is held in the rearward position or until the magazine has exhausted its ammunition.

DURING automatic fire the sear is held out of engagement, and the entire firing cycle is controlled by the forward, or safety, sear. This sear is located on the left side of the receiver and held in place by a flange on the trigger group and by the spindle pivot.

The forward sear is so designed that its rear projection contacts a slot in the hammer. This action prevents the hammer from falling until the bolt is locked in the fully home position.

The heavy-barrel version of the FN is identical with the light-barrel model as far as operating parts are concerned. The only differences between models are that the heavy-barrel rifle has a hinged butt plate, a heavier barrel, and a bipod (see page 1006).

The FN rifles have a rear-type ramp sight, with aperture, graduated up to 600 yards. There is an automatic stop provided on the rear sight to prevent a sight setting greater than 300 yards. For ranges over 300 yards it is necessary for the firer to depress a small spring; this disengages the stop, and the sight may then be moved to any range up to 600 yards.

THE provision for the automatic stop of the rear sight at 300 yards is based on the premise that the average soldier in combat does not, as a rule, engage targets over 300 yards with a rifle.

The rear sight has no provision for manual windage adjustment. The only adjustment provided is by means of two screws which are located at each side of the rear sight. These screws are used when the firer is zeroing his weapon.

If left windage is desired the shooter loosens up the screw on the left side of the sight and tightens the right screw. This adjustment moves the rear sight to the left. When the weapon has been zeroed to the shooter's satisfaction the

screws are then tightened. The manual adjustment of rear sights is eliminated based on the premise that a soldier in combat does not have time to set windage on his sights and therefore usually resorts to "Kentucky windage."

The front sight of the FN rifles is a post-type sight and is adjustable in elevation and depression for assistance in zeroing the weapon.

Each of the above weapons is provided with a pistol grip which is recessed to receive the trigger guard as it is pivoted downward. This provides a cold-weather trigger for arctic firing.

LET us now discuss the T44 rifles. As was previously mentioned, these rifles were developed by the Ordnance Department of the U. S. Army and are modified versions of the standard U. S. rifle, caliber .30, M1.

The light-barrel version, the T44, measures forty-one inches in over-all length exclusive of the flash suppressor. With flash suppressor it measures approximately 44.4 inches. The rifle is gas-operated and weighs only 8 1/3 pounds without magazine.

By means of a selector switch located on the top right side of the receiver the rifle may be fired automatically or semiautomatically. The rifle, like the FN, is also fed from the bottom of the receiver by means of a 20-round magazine loaded with the new NATO, caliber 7.62-mm. ammunition.

A bayonet or grenade launcher can be affixed to the flash suppressor. The T44 also has its counterpart in the T44E1—the heavy-barrel version of the rifle. With a few exceptions to be pointed out later, the two rifles are almost identical in every respect.

Operational power for these rifles is provided by means of a gas cutoff and expansion system. This system provides for a measured quantity of gas to be metered off and allowed to expand, thereby providing the power stroke. It differs from the impingement-type system in that the sharp blow created by the gas on the piston is eliminated.

It is reported that such an expansion-type system is satisfactory, but the author understands that experimentation is being directed toward an impingement-type gas system for any production models of the T44 rifles.

For semiautomatic fire the selector is rotated so that the smooth face of the selector is facing the firer. The function of the rifle for semiautomatic firing is identical with the standard M1 rifle.

To fire the rifle automatically the selector is rotated until the letter "A" is facing the shooter. Continuous depression of the trigger will fire the rifle automatically until the magazine is exhausted or until the trigger is released.

WHAT happens when the selector is rotated for automatic fire? Assuming that a cartridge has been fired from the weapon, the gases following the bullet as it moves down the bore are allowed to pass into the gas cutoff and expansion system.

A certain quantity of gas expands and asserts itself against the face of a short piston which, in turn, acts upon the operating rod, thereby forcing it to the rear. The operating rod moving to the rear compresses the operating-rod spring over the operating-spring guide.

After the operating rod has continued to the rear for approximately half an inch, the camming surface on the inner face of the operating-rod handle contacts the bolt roller, located on the right side of the bolt lug, rotating the bolt counterclockwise and unlocking the action. The firing pin is withdrawn, and the operating-rod handle disengages from the hook of the connector assembly.

THIS disengagement of the connector assembly permits the assembly to move to the rear, thereby rotating the sear-release assembly out of contact with the sear.

The bolt, traveling to the rear, cocks the hammer, extracts and ejects the spent cartridge case, and is finally brought to rest by a combination of the compressed operating-rod spring and a filler plate located at the rear of the receiver.

The filler plate just mentioned would, in all probability, be eliminated from any production models of the T44 rifles. It is necessary in the experimental models to shorten the M1 receivers so the new NATO ammunition, which is approximately half an inch shorter than the standard M2 cartridge, may be fired.

Assuming that the trigger is being held to the rear, the sear engages the hammer hooks and holds the hammer to the rear. As the operating rod moves

The light-barrel FN rifle field-stripped. The weapon weighs about 8 pounds, 9½ ounces, without magazine.

The heavy-barrel counterpart of the T44 complete with bipod rest.

forward, under power provided by the compressed operating-rod spring, the hammer of the rifle is retained in its rearward position until the handle of the operating rod contacts the hook of the connector shaft.

When the handle of the operating rod contacts the connector hook, the connector shaft rotates the sear release, causing the release to press upon the sear. This pressure causes the sear to disengage itself from the hammer, and the hammer is then allowed to fall.

In the event the trigger, during automatic fire, is released, the hammer is prevented from falling because, although the hammer has been released by the sear, the trigger lugs will engage the hammer hooks and hold it to the rear. The action here is identical with that of the M1 rifle.

Upon exhausting the 20-round magazine, the follower of the magazine contacts the bolt-holding device, and the bolt is held in the open position.

THE disassembly of the T44 rifles is, except for a few minor details, similar to that of the standard M1 rifle. It is not as simple as that of the FN rifles, but neither is it complicated. If you can remove the trigger group and the operating rod and spring from the M1 rifle you will have no difficulty in field stripping the T44 rifles (see page 1004).

There are no follower assembly, bullet guide, operating-rod-catch assembly, follower arm, follower-arm pin, or follower rod to remove since all these parts have been eliminated during the change-over to the T44 rifles.

The trigger group on the T44 light-barrel rifle is almost identical with that of the M1 rifle. The main differences in the trigger group of the T44 and the M1 are that the sear of the T44 has a projection extending toward the right for a distance of approximately a quarter of an inch.

This sear extension permits contact between the sear and sear-release assembly, thereby permitting automatic fire. The trigger group of the T44 also has a magazine-catch assembly as an integral part of the trigger group, whereas no such device is necessary on the M1 rifle.

The main differences between the trigger group of the T44E1 and the M1 rifle are that in some instance, the T44E1 trigger group contains a rate reducer and an elongated sear. When the selector is rotated to the automatic position the sear-release assembly is rotated rearward.

When the operating rod moves to the rear in recoil, carrying the bolt with it, the bolt forces the rate reducer to the rear where it is held in the rearward position by the sear release. When the trigger is held to the rear the operating-rod handle, returning to the forward position, contacts the connector hook, and the connector shaft moves forward releasing the rate reducer.

The rate reducer falls, striking the hammer loose from the sear, and, in turn, the hammer falls and strikes the firing pin. The time lag between the release of the rate reducer until it strikes the hammer which, in turn, must strike the firing pin, reduces the rate of automatic fire.

The front and rear sights used on the T44 rifles are identical with those on the M1 rifle.

The performance characteristics of the T44 rifles—such as range, rate of fire, and muzzle velocity—are similar to those of the FN rifles.

As was mentioned earlier, the T44 light-barrel rifle has a heavy-barrel counterpart. The only differences between the heavy- and light-barrel rifles are that the heavy-barrel rifle has a hinged butt plate, a heavier barrel, and a bipod assembly.

Both the heavy-barrel versions of the FN and T44 rifles weigh in the vicinity of thirteen pounds. This weight does not include the magazines.

What conclusions may be drawn from the lightweight rifles under discussion? We can readily see the advantages of having one lightweight rifle with its heavy-barrel counterpart. Just imagine the time that would be saved in instruction periods alone!

ONCE a Marine or soldier has been indoctrinated in the use of the light-barrel rifle, he is competent to man the heavy-barrel rifle since the working parts of both are identical.

Again, since the heavy-barrel version of the lightweight rifles weighs approximately thirteen pounds, as compared with almost twenty pounds for the BAR, the weight saved is a great advantage. Already we are thinking about what the BAR man is going to do with the seven or eight pounds saved.

That is for the tacticians to say, but you can bet your bottom dollar the BAR man of tomorrow, armed with the heavy-barrel lightweight rifle, will be capable of moving faster and will be able to carry more ammunition than at present.

Ammunition-wise, the savings will be tremendous. It will take less brass to make the cartridges, but the saving will come in the fact that the same ammunition will be used in all weapons, rather than the present requirement for pistol, carbine, and rifle ammunition.

On the horizon we can see one weapon replacing four: the new light-barrel rifle will replace the M1, the carbine, and the submachine gun; the heavy-barrel version will replace the BAR.

The heavy-barrel FN rifle with hinged butt plate and bipod.

Electronics for Ordnance

Increasing applications of the electron to the field of weapons include use in instrumentation, radar, proximity fuzes, fire control, and systems for directing and controlling guided missiles

Dr. C. M. Hudson

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SINCE 1940 a revolutionary change in weapon technology has become evident—the use of electronics. Almost all prior weapons operated without any electric circuits or with electric elements (switches, relays, motors, etc.) but without electronic devices. "Electronic" devices are those in which electrons conduct electricity through a vacuum or through gases or semiconductors.

The field of electronics pertains to the electronic devices and to the related circuitry. For example, a radio, a radar, a public-address system—all are electronic. Typical automotive lighting systems are not "electronic" since they use metallic conductors throughout.

Why, then, has this revolutionary trend to electronics taken place in modern weapon systems? Obviously, because of the advantages of performance, precision, producibility, and flexibility.

PERFORMANCE in electronic devices includes sensitivity to extremely weak signals (less than 10^{-14} watt) and ability to handle very strong signals (more than 10^{7} watts), which are a thousand million million million times stronger. Weapons for their guidance need the sensitivity and the high power output obtainable from electronics.

Performance also includes a wide spread in function times, nimble operations in very short times—such as one microsecond, used for measuring bullet speeds—to patient watchdog duty where function must be instantly ready, yet not usually performed for days at a time.

The performance of electronic equipment includes not only wide ranges of power and time but many other functions such as infrared viewing, X-ray inspections, and guided-missile computations feasible only with electronic components for the weapons of today and tomorrow.

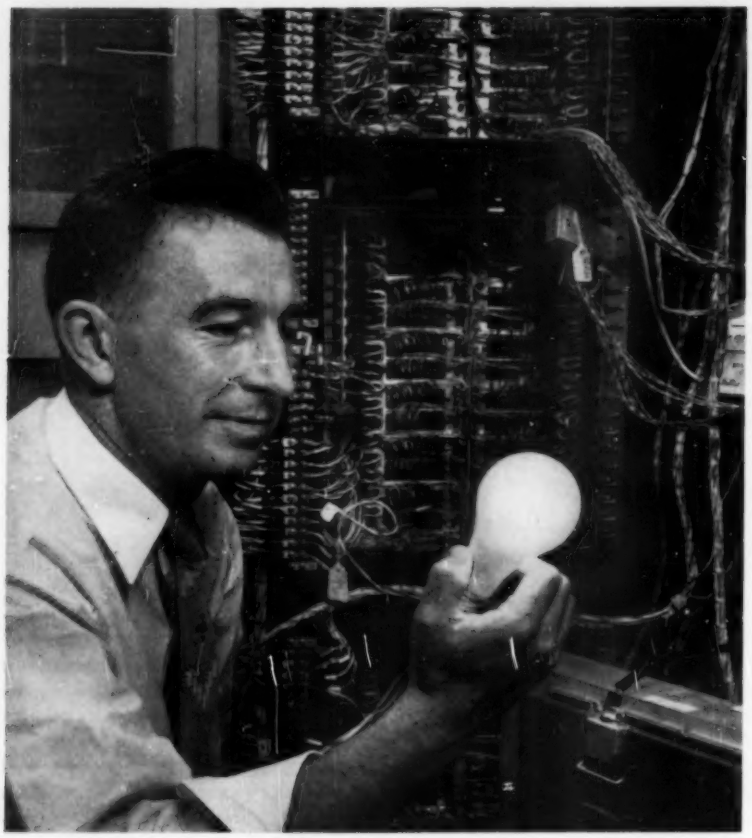
The inherent producibility of electronic components is an essential asset, in military use as much as in the market place. The basic items, resistors, capacitors, inductances (including transformers) and active electronic elements (vacuum tubes, gas-filled tubes, transistors, semiconductor diodes, etc.) are, in general, feasible for manufacture by several independent suppliers. Dimensional tolerances are usually enough to allow long-life capability of mass production tooling.

Electrical tolerances are often surprisingly large. For example, most of the resistors and capacitors, even of high quality, may have at least plus or minus ten per cent tolerance, which permits ready producibility. When necessary, these components can be produced to much closer tolerances.

Precision is an essential characteristic of many electronic circuits. Precision, that is, in the parameter that matters. If we buy a precision frequency standard, its output voltage may vary several per cent, but the frequency remains constant to less than one part per million. But if we want constant voltage (for example, in an electron microscope) a power supply can be built to provide voltage constant to one part in thirty thousand from similar electronic components.

SOMETIMES we need precision in timing pulses—a fragment from an exploding bomb for example as it passes two screens in succession to determine fragment velocity. Sometimes we need precision in counting the waves of a known wave length between weapon and its target. Sometimes, to hit a fast-moving target, we need a precision with speed of calculation which no array of relays or mechanical components can provide. Electronic equipment provides precision where needed.

Flexibility is inherent in electronics design, production, and maintenance. A small number of resistor values can fill most resistor needs. The same is true for capacitors and other components. Even tubes, the most complex and expensive components and the ones most likely to require replacement, find



Designed to operate in aircraft flying at supersonic speeds, the TRADIC digital computer operates on less power than the 100-watt bulb held by engineer above.

most of their application in a few dozen types.

Interchangeability of components from several sources of manufacture is usual. Rapid tooling and changing of subassemblies and of final assemblies is typical of the industry. This, unfortunately, is not true of heavy industry for weapons, especially where extensive tooling and dies are required, nor does it include certain items of electronics which may require new dies or elaborate fixtures. But in many instances electronic parts of weapons systems benefit greatly from the flexibility in use of components and of manufacturing facilities and personnel.

APPLICATIONS of electronics in the field of weapons include instrumentation, radar, proximity fuzes, and guidance systems.

Instrumentation undoubtedly came first, and will always be important as an application of electronics techniques in weapon technology. Some of the early uses were to measure pressure versus time in guns. Circuits with cathode-ray oscillographs were used to obtain ballistic information with which the gun systems during World War II were improved and with which rocket systems were built.

Nonelectronic copper crusher gages still are useful for certain peak pressure measurements in guns, and mechanical (Bourdon) gages were used for one large class of rocket-propellant tests during World War II, but for practical purposes most new knowledge on interior ballistics comes through electronic measurements.

Instrumentation on exterior ballistics likewise comes largely through use of electronic equipment. Perhaps one should say "electronic and photographic equipment" for a great deal of data on projectiles and guided missiles is recorded optically and then reduced with electronic or manual computations. Other data are basically electronic and are recorded photographically.

Instrumentation on all manner of complex phenomena—vibrations, fuel supply, relative positions of parts, pressures, air speed, and drag—operates electronically.

Radar techniques apply electronics in one or more of these essential functions of a weapons system: detection, acquisition, and guidance.

AFTER a target has been detected at a weapons site, by radar or visually, with or without warning from other sources, and acquired—that is fixed as to its coördinates and perhaps its velocity—decision to engage must be made by a human operator, with or without electronic aids, or in the most specialized systems by electronic equipment.

This third function does not utilize radar directly but often depends on data from radar.

We are nearly all familiar with basic principles by which radar transmits a beam of short wave length radiation and receives a tiny fraction of that same radiation reflected from an aircraft, ship, or landmark, thereby finding the direction and distance to the target.

Radar also supplies guidance to many modern weapons firing at predicted impacts or to guided missiles which receive additional information during travel toward the target.

Fuzing constitutes another weapon function in which electronic technique is increasingly important. The proximity fuze is one, but by no means the only, example. In fact the term, "proximity fuze," denotes not just one type but in reality a whole complex array of fuze types. Different physical phenomena, such as radio reflections measuring distance, speed, orientation, or reflectivity; heat, capacitance, sound, or magnetic properties may be used for fuzing. All such fuzes are electronic in construction, with a few possible exceptions.

INCIDENTALLY, sophisticated fuzing is by no means useful only on artillery shell and guided missiles. It can be applicable to weapons which lie in wait for an enemy such as land and underwater mines of all types and even traps for low-flying aircraft.

Highly selective fuzing can, in prin-

ciple, pass by friendly or unimportant situations, yet actuate the warhead when the special situation permits destruction of a primary target. Such fuzing, almost of necessity, requires electronic components.

Guidance systems constitute still another field of application for electronics in weapons. Logically these include the fire-control systems which measure range and point guns and rockets.

Range measurements became quickly accepted, because this measurement is easy and precise with electronic equipment but awkward and not so precise with optical range finders. Therefore, against both aircraft and ships, radar ranging is usual.

ABSOLUTE altimeters for aircraft and bomb sights also primarily measure distance to the ground, from which energy is reflected. Bomb sights, like antiaircraft or naval guns, may be pointed optically under conditions of good visibility, but radar pointing in darkness or fog is mandatory.

Air-to-air fire control because of the small angular size and high relative speed of targets is highly dependent on radar data to control the fire of rockets and guns.

Guidance and control of missiles are in this same situation. Let us use both the terms as pertaining to corrections by which an unmanned vehicle is maneuvered to hit near its target, with "guidance" connoting the determination of proper path and "control" the establishment of proper attitude.

For example, the control of pitch, yaw, and roll in a missile is usually by electronic equipment which actuates control surfaces to keep the missile on its path. Several types of guidance can be cited, of which practically all utilize electronic components—preset, command, beam riding, and homing.

PRESET systems contain, prior to launching, all obtainable information relative to the target. But they do have to correct for wind and anomalies of construction and propulsion. The precision elements are installed and expended in each missile.

Command systems are characterized by the transmission of instructions to the missile for maintaining proper path.

Beam-rider systems have the missile determine what part of the radiation beam it is in, and maneuver to stay near the center of the beam.

Homing systems require a receiver and sometimes a transmitter to detect and point toward energy from a target.

All these, with the possible exception of preset systems, require use of electronic techniques. They are important military applications.

Future trends of electronic arts in weapons can be partially predicted. More electronic applications are inevitable. Their performance, producibility, precision, and flexibility are prime military assets. Better electronic equipment is necessary and obtainable. World War II and Korean experience in electronic maintenance indicates an intolerable situation, and to continue it is inexcusable. The cure is clear, and the trend toward it is under way—to design, develop, build, and operate for rugged, effective military usage.

The advent of transistors, magnetic amplifiers, new power sources, and other components, and of new fabrication methods is a part, but only a part, of this trend. To reach the goal of rugged, reliable equipment will require a great deal of effort and patience. Costs of obtaining reliability in electronic weapons components will be high, but much less than the costs of tolerating low reliability and providing so many check-out and maintenance personnel.

Weak spots can be seen in the application of electronics to weapons. Insufficient understanding is foremost—too few really know the limitations and the capabilities of electronics in weapons for which they are responsible.

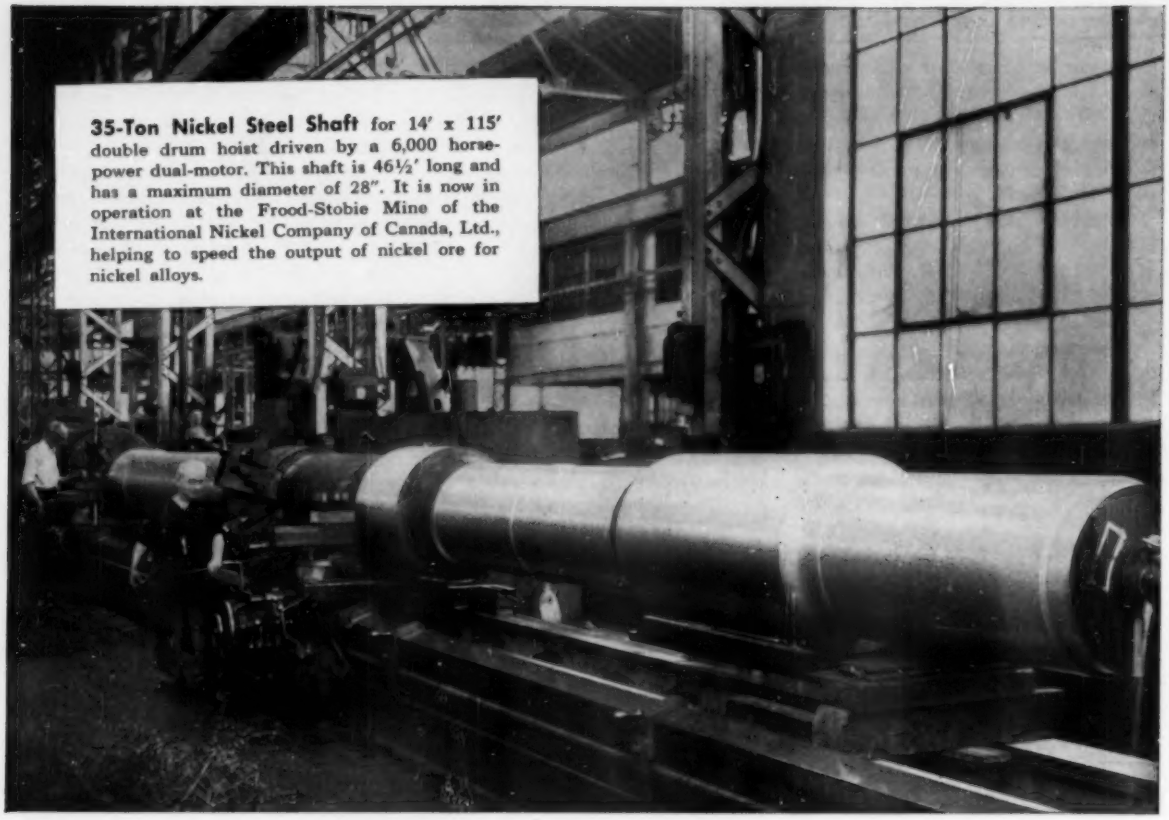
A second weakness is the diversion of attention from primary military needs. Undue emphasis on trivial features and expectation of too many minor functions prevent adequate emphasis on doing the main job reliably.

A THIRD weakness in the present operations of electronic weapons systems is the constant loss of trained operating and maintenance military personnel.

With advanced weapons systems, most of which utilize electronics heavily, a fourth weakness is the innovation and effort required fully to exercise and test the systems. Realistic surprise tests and extremely careful recheck of alignments are necessary to be sure that equipment is not merely "operational" but is also effective at all times.

In summary, we believe that electronics, defined broadly to include magnetic amplifiers and other elements similar to electronic items, provide an exceedingly important part of our capacity for national defense.

The repeater, below, amplifies voices over the new, portable GI telephone system which can handle 4 conversations over a single cable a distance of 100 miles.



35-Ton Nickel Steel Shaft for 14' x 115' double drum hoist driven by a 6,000 horsepower dual-motor. This shaft is 46½' long and has a maximum diameter of 28". It is now in operation at the Frood-Stobie Mine of the International Nickel Company of Canada, Ltd., helping to speed the output of nickel ore for nickel alloys.

How nickel strengthened the shaft for Canada's highest powered mine hoist

IN LARGE FORGINGS such as this giant shaft, high tensile and elastic properties do not come easily.

Liquid quenching of heavy forgings is usually impractical. Even when the shape is such that this treatment may be safely applied, the section sizes involved often restrict cooling to rates which render the quench ineffective.

Increased strength, hardness, toughness and other mechanical properties in a large forging depend to a great extent upon selection of alloy content.

Accordingly, to attain maximum strength and toughness in the shaft of Canada's highest powered mine hoist, at our own Frood-Stobie mine, we specified a shaft forged of 3½% nickel steel . . .

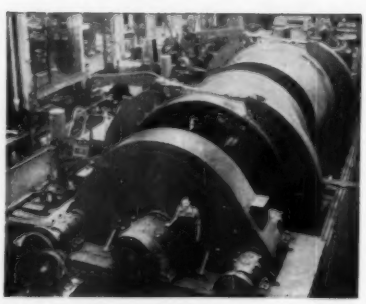
Because nickel, either alone or in combination with other alloying elements, provides a number of advantages.

For one thing, it has a strengthening effect on ferrite . . . independent of carbon content or heat treatment of the steel.

For another, it lowers the rate and temperature of the upper transformation, thus inducing better response to the necessarily milder heat treatments used. And it reduces grain growth.

Whenever you face a metal problem, let us help you make a selection that will meet your particular fabricating and service requirements. Send us details of your applications, for our suggestions.

INCO TRADE MARK



Double Drum Hoist for the Frood-Stobie Mine, during course of shop erection by the builder, The John Bertram & Sons Co., Ltd., Dundas, Ontario. Spiders that support the steel shell of the hoisting drum were cast in an iron containing 1½% nickel . . . to assure adequate strength in the 74,600-pound drum-spider assembly. This hoist, operated by push button control from a station far underground, can lift skips containing 15 tons of nickel-copper ore, at an average rate of 14,000 tons daily.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

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MAY-JUNE 1955

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Sweet music to 20,000,000 people —even in weather like this

In the days before FM broadcasting, a storm like this would have made every radio set in the area impossible to listen to.

Now, about 20,000,000 people in 8,000,000 homes can enjoy static-free reception, even with such violent goings-on outside. What's more, they can enjoy music in all its original beauty, unmarred by interference or distortion, with rich overtones and vibrant basses.

Here at Zenith, we take a special and pardonable pride in our contributions to FM broadcasting. We have always championed this finest kind of broadcasting service. Long before FM was made official, Zenith's experimental station in Chicago was exploring the possibilities of the new medium. Zenith was ready at the bell with sets built on principles laid down by "Mr. FM" himself, Major Armstrong. Early tests in our laboratories proved Zenith sets were then 10 times more sensitive than the average of 16 other makes.

It is with such a background that Zenith is now building more FM sets than anybody else. There are more Zenith FM sets in use today than any other make.

Like so many other Zenith contributions to better living, the FM story was written out of 36 years of experience in radionics exclusively. During most of that time the benefits of our unique experience have served the Government with more effective means of defense.

Zenith's 36 years of experience in radionics exclusively has proved invaluable to the Government in developing electronic and mechanical fuses.

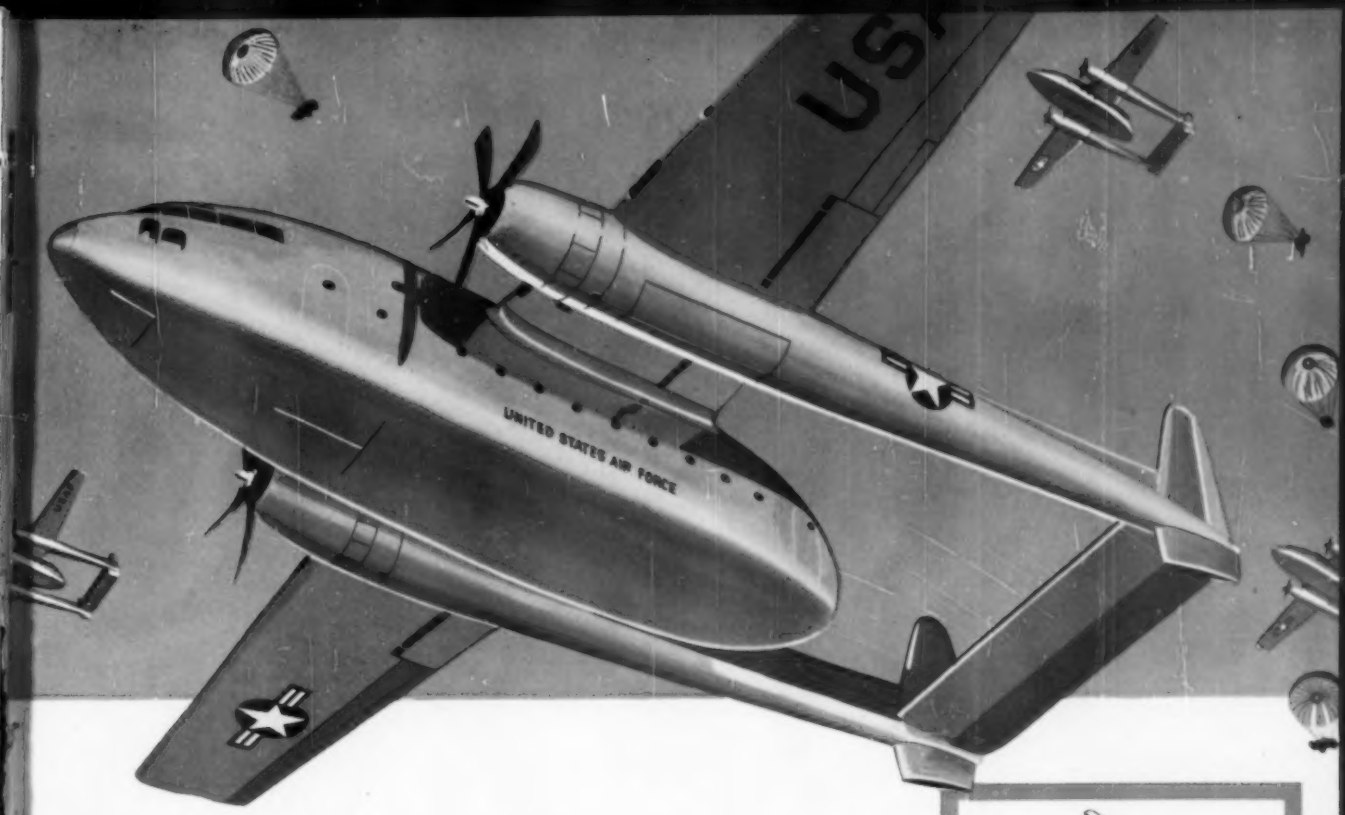
ZENITH

The royalty of RADIO and TELEVISION®

ALSO MAKERS OF FINE HEARING AIDS
Zenith Radio Corp., Chicago 39, Ill.

Zenith, backed by 36 years of experience in radionics, serves America with a stronger defense and a better way of living.

COPR., 1954



BROTHER ACT!

To provide the world with versatile military air transportation, the famous C-119 *Flying Boxcar* joins forces with the C-123 Assault Transport. Together these "brothers-in-combat" roll off the Fairchild assembly lines, and together they land or para-drop men and vital materiel wherever needed.

Carrying over 11 tons payload, the combat-proven C-119 airdrops fully-equipped troops and bulky cargo in forward areas—while the rugged C-123 actually lands on unprepared terrain in the most advanced bases, with full protection to personnel and equipment.

Fairchild, pioneer in military air transportation, is proud of its part in the development and production of this great assault team—one of the world's most vital brother acts.

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